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SOCIETIES FOR CANNON PRACTICE.

EVERY one knows the means by which our artillery captains make a shell fall exactly upon the object to be struck at a distance of three or four thousand yards. The marksman aims with a breech sight corresponding to the distance estimated. The projectile falls in front of or behind the target. If it falls in front, the sight was too short, and it is increased for the following shot, which amounts to giving the piece a larger angle of fire by means of the winch. If the projectile goes beyond the target, it is known that the last sight employed was too long. There is, therefore, nothing more to do but take the mean of the too short and too long sights in order to hit the target at the next shot.

Such is the theory of the regulation, at least for firing in elevation. It is a very simple theory, but of very delicate application in practice, and the difficulty of which is increased tenfold when from such firing we pass to the "spreading," that is to say, when the officer wishes to have the projectile burst in the air at such a height and such a distance that the balls projected by the explosion shall fall like a hail of lead upon the enemy's position.

In order to acquire the experience that they would have need of on a campaign, the officers of the regular army have two kinds of exercises at their disposal—the grand maneuvers and the schools of artillery practice. In the grand maneuvers they study positions and general formations and the methods of defiling, that is to say, of seeing without being seen. In the schools of practice they really fire and learn how to apply the principles of the last method.

But, although the officers of the regular army thus have the facility of learning their profession, it was impossible for the officers of the militia, however much they desired it, to prepare themselves for the mission that they would have to fulfill in time of war. With the new formations, the militia officer is no longer a "pantouflard;" he takes part in the firing like his colleagues of the regular army, generally alongside of them, but often also without them, alone, with the same responsibility as the regular. The militia artilleryman did not go to schools of practice, and he did not go to the grand maneuvers. To organize schools of practice on a large scale would have been impracticable, both on account of material difficulties and cost; so what could not be done on a large scale was realized by the creation of societies for cannon practice. The principal point that distinguishes these schools from those of the regular army is that the firing has been reduced from two or four thousand yards to two or four hundred, and it has been thus possible to use the small proving grounds of such garrisons as Versailles or Vincennes, while the war practice requires enormous surfaces, such as are found only at Fontainebleau, Chalons, Cercottes, Auvours, etc.

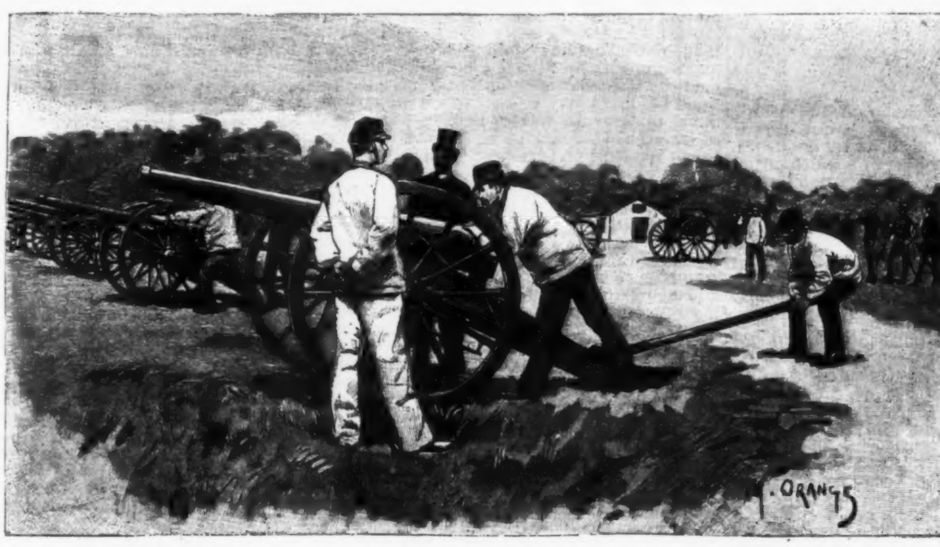
In order to obtain such reduction in range, a very distinguished artillery officer, Lieutenant Colonel Rodolphe, has devised the following ingenious system: In the chamber of an ordinary campaign gun is inserted a tube made especially for the purpose and the caliber of which is the same as that of the machine gun. It is, therefore, the small projectile of the latter that replaces the ordinary 3½ inch shell. Besides, by means of a false chamber of steel arranged to this effect back of the tube in question, the cartridge of about 25 ounces of powder is replaced by an ordinary 16 caliber fowling piece cartridge, with central percussion. Instead of a primer there is a hammer, analogous to that of the Gras gun, maneuvered by the same lanyard that ordinarily serves to set the gun off. In the cartridge there are from 60 to 90 grains of sporting powder.

Thus modified, the piece carries with remarkable precision to mean distances of from two to four hundred yards. Finally, as a corollary of the reduction of distance, the figures at which the firing is done are reduced in the same proportion.

At three or four thousand yards the targets are outlines of the various elements of a hostile army—outline of a man on foot, of a gun, of a cavalryman, pieces simulating a line of infantry, all of natural size.

In order to give the illusion of distance to the officers who do the firing at the reunions of the societies for gun practice, these outline figures have been reduced to the proportions of an army of Liliputians. The men and guns are scarcely a foot in height, and, provided that the proving grounds are covered with a thick growth of grass, everything seems dissimulated therein.

Several societies already exist. The one at Paris, formed in January, 1892, under the presidency of General Tricoche, meets every Sunday at the proving grounds of Vincennes. The officers go thither in uniform. The men often go in citizens' clothes, and put on in place a linen dress to protect their coats from contact with the movable breech or the rammer.



MILITIAMEN PRACTICING FIRING.

FIGURES FOR FIRING AT WITH AN ORDINARY CHARGE.

These reunions are in no wise occasions for dressing as a soldier and playing the officer. The maneuvering there is effected correctly and as scrupulously as in platoons of instruction. There is no loquacity, no freedom; the officers and men understand that they are there for instruction, and of themselves respect a discipline which, however, is not imposed upon them with the severity of a guard room.

The society at Paris, which already comprises 415 officers and 435 non-commissioned officers or gunners, annually organizes for each of its sections competitions in pointing and firing, which are generally followed by real firing at the Fontainebleau proving grounds.

Serious results demonstrate the utility and importance of these societies, which have taken it to heart to enable those who wish it, among our officers and our troops of second line, to complete their technical instruction without great effort and under the form of a recreation that is as attractive as it is useful.

Let us add that General Saussier has accepted the patronage of the Paris society, and that the ministers of war and of the interior, as well as the municipal council, have not been sparing of their aid and encouragement.—*L'Illustration.*

PRESSURE DEVELOPED BY EXPLOSIVES.

By Capt. NOBLE, C.B.

ARTILLERISTS have agreed that, except under certain circumstances, the maximum working pressure in a gun should not exceed 17 tons per inch or about 2,500 atm. Now if cordite and pebble powder are taken as illustrations, it is found that with the former explosives it is possible to obtain with the same maximum pressure as much as 50 per cent. more energy than with the latter, the extra energy being obtained by the development of higher pressures in the fore part of the gun. It therefore becomes a matter of considerable importance to ascertain if these higher pressures in any way affect the safety of the chase.

Guns were prepared having crusher gauges placed at various points along the bore, and the results obtained were compared with those obtained by altogether independent means. In the author's opinion the crusher gauge is perfectly reliable so long as the products of combustion do not enter the gauge with a higher velocity, which, however, will necessarily be the case if the gauge is placed in the forward part of the gun, where the products are in rapid motion. The author arranged a 4·7 in. Q. F. gun in such a manner that he was able to obtain a curve determined from the time at which the projectile passed 16 points along the bore. From this curve, by methods elsewhere described, the curve giving the velocity at all points of the bore can be deduced, and from the velocity curve can be deduced the pressures generating these velocities.

The explosives used were as follows:

(*a.*) *Ordinary Service Pebble Powder.*—A charge of 12 lb. gave rise to a mean pressure of 2,424 atm. (max., 2,566; min., 2,277) as determined by the crusher gauge in the powder chamber. It gave to a 45 lb. projectile a mean muzzle velocity of 1,839 ft.-secs., corresponding to a muzzle energy of 1,055 ft.-tons. 1 grm. of pebble powder at 0° C. and 760 mm. generates 280 c. c. of permanent gas and develops 720 grm. units of heat.

(*b.*) *Amide Powder.*—A charge of 10 lb. 8 oz. gave rise to a mean pressure of 2,332 atm. (max., 2,500; min., 2,165); muzzle velocity, 2,036 ft.-secs.; muzzle energy, 1,293 ft.-tons. 1 grm. of amide powder generates 400 c. c. of permanent gas and develops 821 heat units.

(c.) *Ballistite.*—A charge of 5 lb. 8 oz. developed a mean pressure of 2,180 atm. (max., 2,210; min., 2,142). Muzzle velocity, 2,140 ft.-secs.; muzzle energy, 1,429 ft.-tons. 1 grm. generates 615 c. c. of gas and 1,365 heat units.

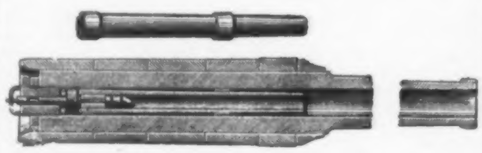
(d.) *Cordite.*—Charge, 5 lb. 8 oz. Mean pressure, 2,027 atm. (max., 2,070; min., 1,970); muzzle velocity, 2,146 ft.-secs.; muzzle energy, 1,437 ft.-tons. 1 grm. at N. P. T. generates 700 c. c. of permanent gas and 1,260 heat units.

The author gives a figure showing these results graphically. The ordinates show both the positions at which the pressures were determined and the magnitudes of these pressures in tons per square inch. On the axis of abscissæ is shown the travel of the shot in feet. In the calculation of the pressures it is assumed that the pressures will uniformly increase and then uniformly decrease before and after complete ignition of the explosive. It is improbable that this assumption is strictly true, as even when the combustion is comparatively slow it appears probable that there is a generation of gas in various parts of the bore causing a difference in pressure. The author thinks that some of the discrepancies of the crusher gauge when placed in the forward parts of the gun may be due to these differences in pressure. These irregularities, however, would not seriously alter the curves and would have no appreciable effect upon the strength of the gun in a radial direction.

THE MARINE WEAKNESS OF GREAT BRITAIN.

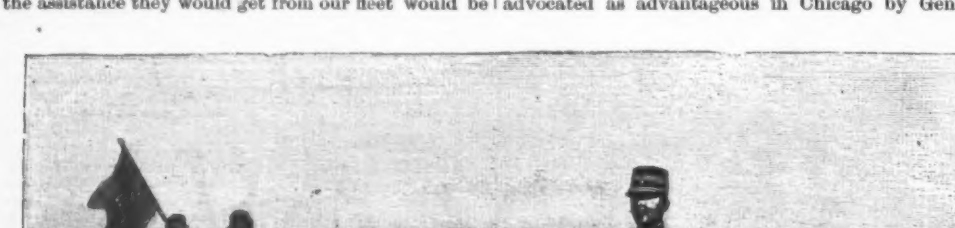
Captain Lord Charles Beresford, C.B., R.N., recently delivered an address to the London Chamber of Commerce on "The Protection of the Mercantile Marine during War."

He went on to say that no policy of defense for our enormous empire could be fully complete unless it was thoroughly recognized that the safety of the mercantile marine was of as vital importance as the strength and efficiency of the Royal Navy. As matters were at present arranged, there was no definite policy whatever which would insure either the delivery of the food or the raw material necessary for the very existence of this country in time of war. More than one-third of all the shipping in the world was British, to protect which Great Britain had one cruiser or sloop of over 900 tons to every 71 merchant vessels, and one cruiser or sloop of the same tonnage to every 41 steamers. France, on the other hand, possessed one cruiser to every 30 ships, and the same to every 11 steamers. As 70 per cent. of the carrying power of the world was in the hands of the British, it was only fair to suppose that the greater proportion of these goods were carried in British bottoms. We ought to have a fleet of 20 battleships for a reserve, instead of one, as was the case, in order that the Royal Navy might be able without question to carry out all the varied duties that would imperatively fall upon it in time of war. The necessity for a reserve had been made very apparent by the accidents that had occurred lately in time of peace, one being overwhelmingly sad, and such as had evoked the whole nation's kindly sympathy. Of armored cruisers the British had 19 and the French, the only people that could compete with us for the command of the sea, 10, but our majority was made up of several vessels of a far older type than our neighbors. Exclusive of the Belier and Thetis, which were classed as *sans valeur sérieuse*, the French had 13 coast defense vessels, the same number as the English, but ours were very inferior. Of cruisers of all sorts, other than armored, Great Britain possessed 125 and France 55. These facts referred to military cruisers only. He believed the 52 cruisers, naval, with the assistance they would get from our fleet would be sufficient for the protection of our commerce against the attack of the one nation under consideration, provided a "blue water route" were used; but in no way were they sufficient if we used the narrow seas or Suez Canal route, so cleverly studded with torpedo bases of operations, unless those bases were first destroyed. Lord C. Beresford dealt exhaustively with the danger which would beset the mercantile marine in using the Suez Canal route in times of war, consequent upon the large number of torpedo stations and torpedo boats possessed by the French along that route. Looking to the palpable dangers which existed to our water-borne commerce on the route which led through the narrow seas, would it not, he asked, be wise for us, as a great nation, to think out practically the possibilities of exchanging these dangerous paths for some that were safer? Then he turned to the great question which, if the routes be changed, must be thought out—viz., that of coaling the mercantile fleet. Whatever route might be chosen, Gibraltar was fundamentally the most important strategic position belonging to the British empire. Inadequate as it was at present, it would have to be a naval base of operations. The real and paramount use of Gibraltar depended upon its capability of being a thoroughly effective and powerful base, both for the mercantile and military shipping. As Gibraltar was at present furnished it would be completely unable to



1. Charging tube for reduced firing. 2. Position of the tube in the gun.

undertake those duties which its unique natural formation should enable it to perform. The reserve ammunition at Gibraltar for the fleet was so ludicrously inadequate that it would not be proper for him to make known the actual amount. The first and immediate necessity, and one that should be taken in hand before money was spent on any other base of naval operations, was to lengthen the mole at Gibraltar. Another serious matter was that at the present time there was no system of signaling among the mercantile marine suitable for any emergency. The present international code (the only means of communication) was more than 40 years old, and there was no explanation in the book to show a novice how to take or make a signal. There were many in the House of Commons and in the mercantile community who believe that our difficulties with the mercantile marine in times of war would be surmounted by taking advantage of the Declaration of Paris, and placing our ships under foreign neutral powers. If the declaration was to be effective our steam mercantile shipping, which was valued at over £100,000,000, should be immediately transferred to a neutral flag. But how was this to be done when one of the conditions of the declaration was that "the captains and crews had to be, if not entirely, almost entirely of that nationality whose flag was represented at the peak." Another point was that the only nation we had to fear did not recognize the neutral flag at all unless all arrangements connected with the transfer took place previous to the declaration of hostilities. In conclusion, he said that the more the questions he had touched upon were ventilated by the mercantile community itself the sooner our weak spots would be exposed and our country freed from those periodical panics so extravagant to the nation and so prejudicial to commercial interests.



FIGURES FOR SHORT RANGE FIRING.

PILE FOUNDATIONS, CHICAGO.

The use of deep pile foundations has been strongly advocated as advantageous in Chicago by General William Sooysmith, M. Am. Soc. C.E., and in a recent issue of the *Technograph* he describes the work done in this direction for the foundations of the new Public Library building in that city. The system consists in abandoning the spread foundation of steel and concrete resting on the unstable clay which underlies most of the business parts of the city, and employing instead a foundation of deep piles reaching down to the bed of compact clay and gravel about forty-five feet below the city datum. The reason advanced for this change by General Sooysmith is that where independent spread foundations are used some of the largest buildings have been observed to settle irregularly after completion. The deep piling is claimed to be much more stable.

In the new Public Library building trenches were dug on the lines of the walls sufficiently wide to permit the necessary shoring, and to include three rows of piles driven about three feet between centers. The character of the upper clay stratum at this place is shown by the fact that it crowded through the smallest crack in the sheet piling almost as if it were quicksand. The depth of excavation permitted sawing and capping the piles to a point such that the highest level of timber used in the grillage is fourteen feet below the city datum, which is about the level of Lake Michigan. From this grillage rubble masonry is carried up to the neat masonry courses of the basement. While the work was in progress, a test was made to determine the bearing power of four of the piles of Norway pine, after they had been driven in the trench. The driving was done with a steam hammer weighing in all 8,300 pounds, the hammer alone weighing 4,500 pounds, and delivering 54 blows per minute with a stroke of 42 inches. The last 20 feet of the driving was done by means of an oak follower. These piles were driven about two and one-half feet between centers.

The bearing power of the four piles was tested by building a platform on top of them, which was loaded with pig iron. Levels were carefully taken on each of the four. The piles stood four days with a loading of 5½ tons per pile, eight days with a loading of 37·3 tons per pile, and ten days with a load of 50·6 tons, all without a settlement exceeding 0·01 foot. In discussing these tests General Sooysmith states that if 250 pounds per square inch be estimated for point resistance, the average frictional resistance will be about 3·2 pounds per square inch of side surface of pile, or about 432 pounds per square foot. For an ordinary pile, 7 inches through at the top and 14 inches at the butt, driven 45 feet, the frictional resistance he assumes to be 59,000 pounds and the point resistance 6,000 pounds. Hence he computes a total earth resistance of 65,000 pounds with a factor of safety of from 5 to 6. The resistance of the pile considered as a column he estimates at 65,000 pounds, with a factor of safety of 3 to 4.

Another noticeable building on deep piles is the new Illinois Central Railway passenger station in Chicago, a structure 180 × 220 feet in plan, and consisting of an office portion nine stories high, a tower thirteen stories high and a station three stories high, with which is connected an eight-track train shed 680 feet long. According to a paper in the same magazine, written by C. J. Mitchell, an assistant civil engineer of the railroad, borings taken on the site showed from 10 to 20 feet of rubbish which had been dumped there immediately after the great fire, below which were irregular strata of stiff blue clay and quicksand. Rock was more than 60 feet below the surface. This condition of things led to the adoption of deep pile foundations. About 1,700 were driven in all, arranged in groups or clusters under each column. Under the head house there were eight, thirteen and sixteen piles in the groups, under the office twenty to forty-two, and under the tower one of the corner pilasters had seventy-three piles. These piles were usually arranged on the square, lining both ways, but alternating in rows 18 inches apart, so that the distance between centers was 25½ inches. This is said to be as close as they could be driven, and even when the points were spaced in this way the tops were sometimes considerably out of line after driving.

In size the piles were from 40 to 60 feet long, averaging 51 feet, and from 11 to 16 inches through at the butt end. Thirty-two per cent were black gum, 22 per cent. pine, 7 per cent. basswood, 21 per cent. oak, 15 per cent. hickory, with a few maple and elm. A cast iron cap was used in driving, but in spite of this 8 per cent. of the heads were crushed or split. The pine piles had the poorest driving record, the heads of 12½ per cent. being crushed and 5 per cent. broken. The gum had 7 per cent. crushed and 0·6 per cent. broken; the oak had 5 per cent. crushed and 0·8 per cent. broken; the hickory had 3 per cent. crushed and none broken, and the basswood had 8 per cent. of the heads crushed. In several of the oak piles the sap wood was separated from the heart, the cores being driven through the shells. All the piles were cut down to form a point 4 inches square.

Drop hammer drivers were used on this work, the hammers weighing 2,800, 3,200 and 3,800 pounds respectively. The best record, 26 piles driven home to a depth of at least 60 feet, was made by the driver having the heaviest hammer, although there is some doubt in Mr. Mitchell's mind as to whether this result was due to the greater weight of the hammer or to the greater ability of the crew in charge. The last blow was generally given with a fall of 35 to 40 feet, though when driving close to a building a fall of 50 feet was used with about the same success. The penetration at the last blow averaged about 3 inches, though a number went less than 1½ inches. The cap prevented much loss by brooming. The distance to which could be traced the vibration due to the driving varied with the fall, the character of the soil, and the spacing of the piles. It was easily felt at 400 feet, while the effect at 75 feet was quite marked. It is stated, however, that in doing instrumental work the vibration was sometimes less severe within 25 feet of the driver than at several times that distance.

The piles were usually driven in groups until the tops of all were below the leads, when the driving was completed by means of a follower. Water was kept running around the pile at the surface while the driving was in progress, as this seemed to be of considerable aid. After the piles had been driven the tops were sawed off to a uniform height of 3 feet below datum, in order that all the timber should be below low water. As this was from 10 to 14 feet below the surface, the trenches had to be sheathed and kept drained by continual pumping. After the piles were cut off and the earth excavated 18 inches below their tops, rich Portland cement concrete was tamped in even with the tops. Oak caps 12 inches square were then drift-bolted to the center of each pile, and the space between the timbers filled with concrete. It is believed that this piling will last many years, as pile trestles built twenty-one years ago on the same railway are stated to be per-

fectly sound now wherever they were below the permanent water level.

A rather interesting set of observations on the effect of pile driving on adjacent objects is described by Mr. Mitchell. In one instance a group of sixteen piles was driven about 15 feet from a group of eight which had been sawed off to a uniform height and had waling pieces drifted on. These waling pieces were raised 4 inches on the side next the driver and one inch on the opposite side. Under similar conditions, when sixteen piles were driven about 15 feet from a finished pier consisting of eight 47 foot piles, 2½ feet of grillage and concrete, and 12 feet of stone masonry, the pier rose five-eighths of an inch on the side next the driver, but on the further side it remained at the original elevation. Two weeks later this pier was again tested, and the high side was found only one-fourth of an inch too high, while the other side had not changed. Again in a group of seventy-two piles a spike was placed in the head of the first pile driven, and elevations were taken daily. The first two days the pile sank one-half inch, then rose steadily until fifty piles had been driven, when it was three inches above the first height, the greatest rise in one day being three-fourths of an inch. This pile was 55 feet long, of which 45 feet were in the ground.—*Amer. Architect.*

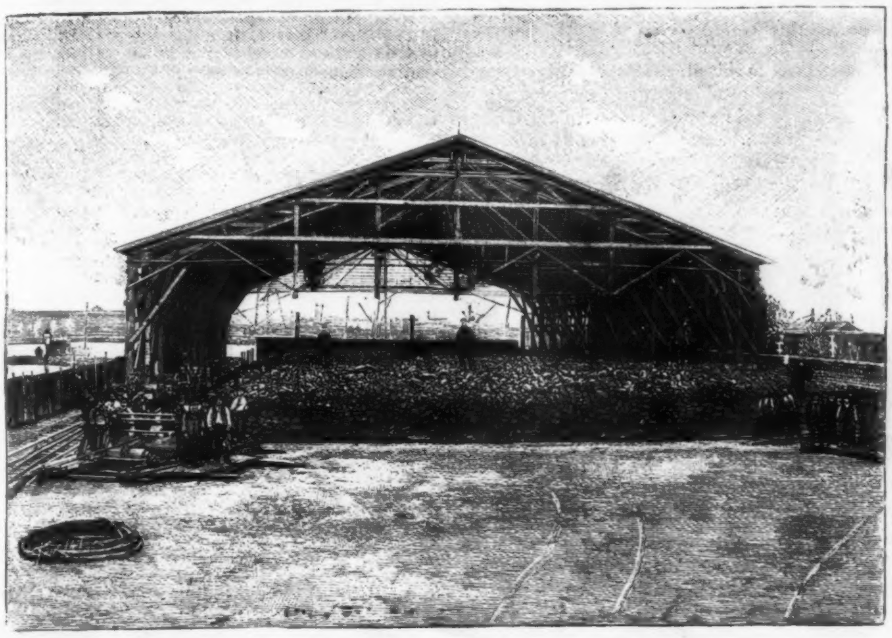


FIG. 1.—A SHED WEIGHING 330,000 POUNDS MOVED BODILY AT ROUEN, FEB. 18, 1893.

MOVING OF A SHED AT ROUEN.

ALTHOUGH the science of the engineer has accustomed us to all sorts of surprises, the moving of a structure which by its nature seems destined to the completest immobility is always an interesting operation. The spectators do not view without a certain thrill the preparations for the start and the first motions of an edifice that is changing residence.

America, as might have been expected, has shown us the example in the moving of a large hotel. The structure, embarked upon twenty-four lines of railway, was hauled to its new site by locomotives.

In France we still hesitate to bring locomotives into requisition, for the net cost, which the Americans do not take into consideration when it is a question of doing something extraordinary, cannot be disregarded by us. Along with the materially possible we are forced to take account of the pecuniarily possible. To do well and at a small expense is a problem of which the solution is assuredly very difficult; but our engineers excel in using such resources as circumstances offer them. This is a talent that doubles the measure of their knowledge.

The shed at Rouen that engineers Duveau undertook the removal of is a large structure (Fig. 1). It is 50 meters in length by 30 in width, of a single span. It is composed of twelve trusses of the Polonceau type, forming twelve spans 4·5 meters in length. Its weight may be estimated at 150,000 kilogrammes, to which must be added the weight of the rolling material, about 32,000 kilogrammes, say, in round numbers, 182,000 kilogrammes.

It was constructed in 1879 after plans by the same engineers, for Messrs. Renaux, Sons & Boupain, who sold it a few years ago to Mr. F. Depeaux, Jr. The construction of the new road from Rouen to Croisset necessitated the condemnation of the building. It was afterward resold by the city to Mr. Depeaux, on condition of its removal in order to clear the land, which will be occupied by the new route. Now, back of this shed and along Jean-Ango Street, Mr. Depeaux owns a sufficient extent of land to receive it. After some study, it was resolved to move it thither bodily in the direction of its axis and to a distance of 53 meters. The slope of the ground is insignificant. In their new position the posts rest upon stone blocks that are but 22 centimeters higher than the old ones.

The delicate point of the operation consisted in moving the twenty-four posts simultaneously without in any way altering their relative positions. It was not difficult to see that a distortion of the rectangle forming the base of the structure would lead to a disaster. Afterward it was necessary to operate with easily procured traction apparatus under the penalty of increasing the expense to an untoward degree. Two windlasses, some cables, etc., that had formerly served for hoisting some lighters upon a dockyard still existed in the possession of a builder of the city of Rouen. It was a material of traction right on hand, and it was utilized. It was easy to bring to the scene of operations some ties, some rails, and some dirt-car wheels and axles.

It was with this second-hand material, in a more or less good state, but very economical, that Mr. Vallette undertook the construction of the track and rolling stock. The preparatory work, consisting in the construction of the new beton foundations, the removal of the siding of the shed and the earthwork for the laying of the track, was begun on December 16, but the snow and the intense cold necessitated quite a long interruption. During this period of rest the framework trucks for the posts were constructed, the windlasses were placed in position, and the rails and ties were brought to the scene of operations. It was finally possible to begin the laying of the track and the mounting of the trucks on February 9, 1893, and on the following Thursday (the 16th) the whole was finished, and in the afternoon the first experiment in traction was made.

The traction, which was exerted directly upon the front post, having caused the washer and nut of the draught bolt to penetrate the wood of the first tie, without producing the least advance of the shed, it was deemed prudent to aid the starting by causing a powerful jackscrew, maneuvered directly by hand, to act upon the next to the last post of each row. Then the starting was effected without a shock. Once *en route*, it was indispensable that each series of posts should move forward exactly the same distance in the same time, in order to prevent any going out of true prejudicial to the solidity of the structure. In order to measure the advance, there were arranged, parallel with each of the tracks, rods divided into decimeters, and a needle invariably fixed at the head of the first track of each convoy.

This needle thus indicated at every instant the position of and the headway made by the train. At every line there was a man who watched attentively and announced in a loud voice the moment of the passage of the needle over each decimetric division. In case of disaccord, signals were made to the men who maneuvered the windlasses. The motion was quickened or retarded as need might be in order to re-establish the parallelism. This very simple means gave excellent results. The deviation never exceeded 5 centimeters—an insignificant figure, seeing the wide span of the truss. Not a crack was heard, and not a glass was broken.

Saturday, February 18, was the day fixed for the final displacement. Mr. F. Depeaux, Jr., owner of the shed, had invited a certain number of persons to witness this important operation. . . . At two o'clock sharp, Mr. Duveau gave the signal to start. The ropes immediately tautened, the slight, quick sound characteristic of the first shock was heard, and the huge framework advanced toward its new destination.

It was truly an astonishing spectacle to see this mass moving without noise, and, so to speak, of itself, for the motive windlasses were hidden behind a structure of planks designed to preserve the workmen in case of a snapping of the traction cables. As for the guests, they stood without the least fear in the very interior of the shed, taking, watch in hand, the speed of displacement of the vast hall that sheltered them.

Toward five o'clock all was finished. The shed had reached its new site without the least injury.

The accompanying engravings will give an idea of the importance of the work that we have described. Fig. 1 gives the aspect of the shed in its primitive place, with the mass of coal that it covered. To the right and left is seen the installation of the windlasses, with gearings of a ratio of 1 to 15, with a second drum in front in order to prevent the displacement of the cable. The latter, starting from the windlass, passes over two apparatus, forming a quadruple pulley block, one end of the rope of which is fixed to a strong stake and the other to the truck of the first post.

In Fig 2 is seen, in the foreground, the last truck with the traction arrangement, the ties and their wedges placed after the lifting between the longitudinals and the ties. An iron tie bar runs from one track to the other. One will remark the arrangement of the St. Andrew's crosses, designed to prevent the distortion of the framework.—*La Nature.*

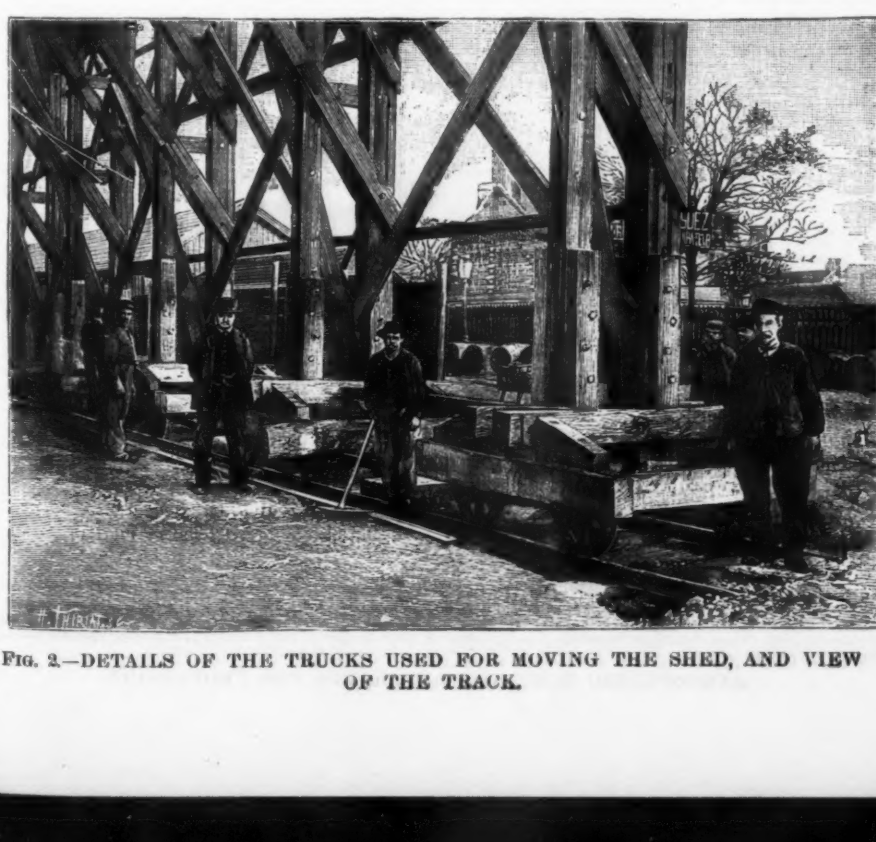


FIG. 2.—DETAILS OF THE TRUCKS USED FOR MOVING THE SHED, AND VIEW OF THE TRACK.

WEICHER'S FIBER EXTRACTING MACHINE.

THIS fiber extracting machine is constructed by J. J. Weicher, 108 Liberty Street, New York. It is now on trial in this country under Mr. Weicher's supervision at the Carlton Works, Printing House Yard, Hackney Road, London, N.E. The chief interest at the present moment attached to fiber machines is based on their capability to clean leaves of the sisal hemp plant, so largely planted at the Bahamas and elsewhere. This brief report is therefore almost entirely confined to the treatment of leaves of this sort. Recently, accompanied by Sir Alfred Moloney, Governor of British Honduras, I accepted an invitation to see the Weicher machine at work on agave leaves obtained from the Riviera. The leaves were those of *Agave americana*. They had been cut about a fortnight, and hence they were not in the best possible condition for being experimented upon.

The Machine.—The machine consists of a drum fitted with beaters, and a feeding table mounted on an iron frame about 14½ feet long and 2½ feet wide. The whole structure is of iron, fitted with beaters composed of a mixture of copper, aluminum and iron attached to the drum where it comes in contact with the juice of the leaves. The general principle of the machine is similar to the "Gratte" in use in Mauritius, and the "Raspador" of Yucatan. The leaves, as in these machines, are presented endwise, and are cleaned by the beaters attached to the drum. About one-half of each leaf is cleaned at one time. It is necessary to change the position of the leaf before the other half can be cleaned. There is, however, no reverse action, and in this respect the Weicher machine possesses an advantage over other machines of the same type.

The Feed Table.—The feed table consists of an endless band composed of flat iron laths fastened across two iron chains. The band is fitted with iron clamps for holding the leaves in position and presenting them to the beaters in such a position that at first about one half of their length is cleaned. After this the leaf is carried continuously back on the underside of the band, and brought out so that it can be seized by the operator and its position changed. When it is next presented to the beaters, the uncleaned part is treated and the whole of the fiber is then carried out and removed from the machine. The feed table is therefore automatic, and it will carry at one time about four or five leaves. These may be any length up to about eight feet, and the quickness of the cleaning depends

very much upon the activity and aptness of the operators.

Serving the Machine.—For regular working a man and two boys are required. The man and one boy attend to the feeding and the changing of the leaves, while the other boy takes out the cleaned fiber and hangs it up to dry.

The Trial.—The machine was worked recently at intervals for about an hour. It readily cleaned agave leaves of various sizes, some only half an inch thick and others between two and three inches thick. There is an arrangement of levers to allow for yielding in case of very thick leaves, and the machine was not clogged or stopped during any portion of the trial. This is an important consideration. The quality of the fiber produced was on the whole good. There was but little waste, and none of the strands was damaged or broken. The samples cleaned are now at Kew. Nothing has been done to them since they left the machine.

Washing the Fiber.—Where there is an abundant supply of fresh water, an arrangement could be made whereby the fiber might be washed while passing under the beaters. This, however, is not an essential part of the cleaning. It may be adopted or not, according to local circumstances.

Particulars of the Machine.—The following particulars were obtained from Mr. Weicher. The total weight is 3,100 pounds (avoirdupois). The space occupied by the machine with feed table extended is 14½ feet long by 2½ feet wide. The power required is 10 horse power, giving 500 revolutions per minute. The inventor has worked the machine in Yucatan for a period extending over nearly three months. One machine is still in Yucatan.

Yield of Fiber.—Mr. Weicher claims it will treat 10 to 12 tons of green leaves in a day of 10 hours. Allowing the leaves to yield 3 per cent. of fiber (in a prepared dry condition), this would be at the rate of 672 pounds per day as the lowest return, with a possible return (at 4 per cent.) of 896 pounds per day. As far as could be judged from the recent trial these returns are not improbable. It is, however, impossible to offer a definite opinion on the subject. The actual capacity of the machine can only be determined by continuous working on a sisal hemp plantation, and with operators who have become thoroughly accustomed to it. In a report on the sisal hemp industry of Yucatan, prepared for the government of the Bahamas by Captain E. Jerome Stuart [*Kew Bulletin*, 1892, p. 275], it is stated that the Weicher machine "requires 12 horse-power engine and the services of three men. Capacity 2,500 pounds dry fiber per day of 10 hours." Mr. Weicher judiciously disclaims all responsibility for the capacity here given. He prefers to indicate it by saying that the machine will treat at the rate of 10 to 12 tons of green leaves per day. The actual yield in dry fiber will therefore depend upon the quality of the leaves. Mr. Weicher hopes to obtain as high as 5 per cent. of dry fiber from good leaves, and he thus estimates the out-turn per day of 10 hours at 1,120 to 1,340 pounds. These figures, it is needless to add, are given entirely on his authority. For comparison from actual working it may be mentioned that the Yucatan Raspador (with two men) acting on leaves of sisal hemp will clean about 400 pounds of dry fiber per day. On the other hand, the Mauritius machine (also with two men) acting on leaves of the green aloe (*Furcræa gigantea*) will turn out only about 214 pounds of dry fiber per day. The difference in these returns may be due to the different qualities of the leaves, but it is evident that, so far, neither of these machines working on a commercial scale is able to turn out more than 400 pounds of dry fiber per day.

The conjectural figures given by Mr. Weicher require therefore to be received with due reserve until the performances of the machine have been fully tested.

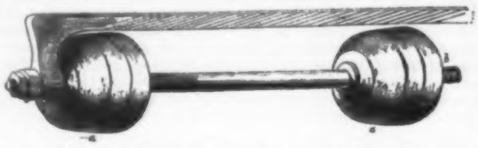
Summary.—I may add that I have seen most fiber machines that have been brought forward and tested during the last 12 years. I am not yet in a position to say that any machine has fulfilled all the conditions necessary in cleaning sisal hemp fiber. The whole of the Mauritius hemp (from *Furcræa gigantea*) exported from that island is cleaned by the Gratte, locally made and costing about £3 [*Kew Bulletin*, 1890, p. 98]. This has to be fed with one or two leaves at a time, and there is considerable waste. There is also some risk to the work people, who have to hold the leaves in their hands while they are being cleaned. The Yucatan fiber is chiefly, if not entirely, cleaned by the rough contrivance known as the Raspador, also locally made [*Kew Bulletin*, 1892, p. 37, with woodcut]. The working of this is slow and wasteful, but with very cheap labor the industry is apparently very remunerative when prices are high. There is probably little or no inducement, owing to cheap labor, to introduce improvements in fiber cleaning in Yucatan. In the Bahamas the circumstances are entirely different, and a satisfactory machine is indispensable. The various machines that have hitherto sought to supplant the Gratte and Raspador, such as the "Death machine," the "Barraclough machine," and others, have all turned out better qualities of fiber, it is true, but the total yield has been small and disappointing. In fact, taking into account the great efforts made to introduce and popularize these machines, their extended use on a commercial scale has made little or no progress of late years. The Weicher machine possesses distinct merit, and it is more promising than any (so far as I have observed) with an automatic feed table. It may be said against it that it is somewhat heavy and intricate, and its price (not yet fixed) must be higher than either the Gratte or Raspador. It deserves, however, to be tried under suitable circumstances, and those interested in the fiber industry of the Bahamas, for instance, cannot do better than carefully test it on the spot. The inventor would then have an opportunity of showing its capabilities in the presence of an unlimited supply of leaves. It is impossible to do more in this country than form an approximate idea of its merits. It may be added that it is claimed for the machine that it will clean the leaves of bow-string hemp (*Sansevieria*), banana (*Musa sapientum*), and possibly also pineapple and ramie. None of these, unfortunately, were available at the recent trial.—*Kew Bulletin.*

JERUSALEM is still supplied with water from Solomon's Pools, through an aqueduct built by the Crusaders.

THE ATMOSPHERIC RAILWAY.

RECENTLY, in looking over an old volume of the *Pictorial Times*, published in London in 1848, we came across some illustrations of a plan for an atmospheric railway, which we have deemed of sufficient interest here to reproduce. The following is the description:

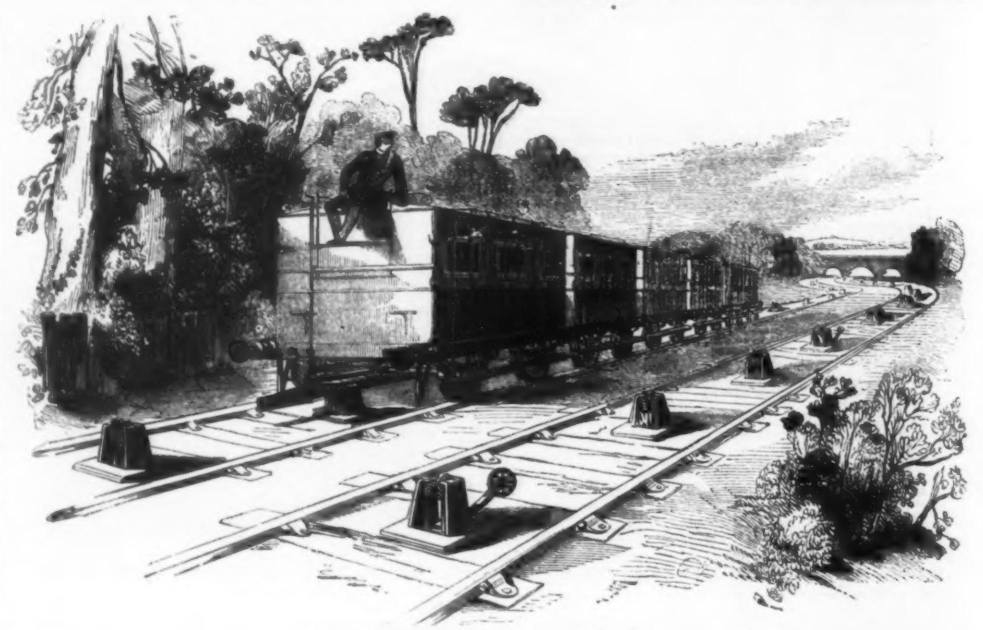
The several atmospheric plans submitted within the last twenty years to public notice for propelling carriages upon railways have all had, in common, a main pipe, a piston or diaphragm fitting this pipe, an air pump to exhaust it, and a connecting apparatus between the piston and carriage, through a continuous slit or valve along the top of the main pipe, which valve had to be ripped up every journey by the passing of the carriage, and cemented down again for the next exhaustion. The presence of this continuous valve seems ever to have been considered a *sine qua non*, with all the difficulties arising from it, and to connect a carriage outside the pipe to a piston inside so that the one shall be acted upon by the other without this opening seems never to have been dreamed of in the philosophy of the several projectors of atmospheric railways, yet this difficulty Mr. Pilbrow has, in a most ingenious manner, overcome. He has succeeded in dispensing with this valve, and is at the same time able to connect the carriage and piston together, and, what is most important, to accomplish crossings on the main line.



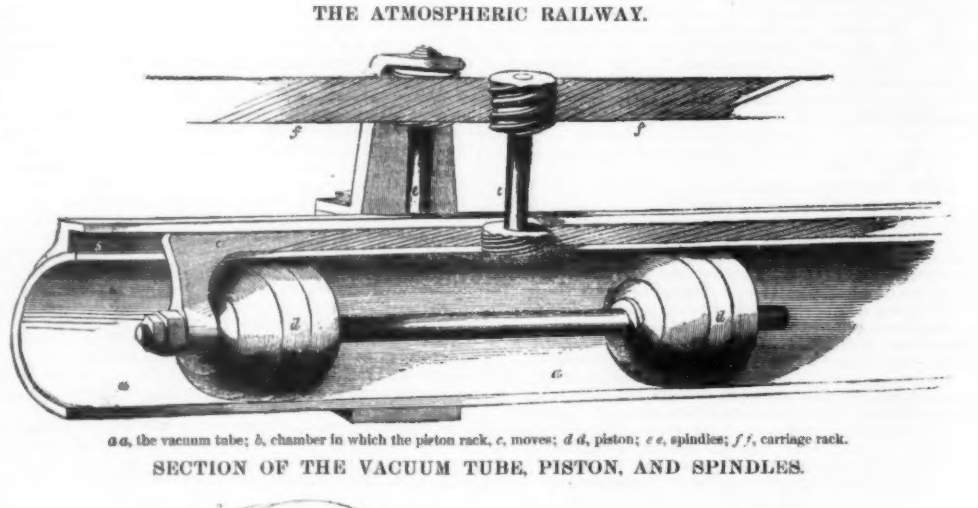
a a, the piston, made of ir[illegible]n, with an edging, *b b*, of thick leather, which fits clo[illegible]y to the tube; *c*, piston rack.

PISTON AND PISTON RACK.

The apparatus, as at present arranged, consists of a tube with a small square chamber above. In this chamber, at given distances, are small square boxes, into which a pair of spindles are perpendicularly inserted, having a small wheel at either end, with oblique threads or channels on its surface. The edges

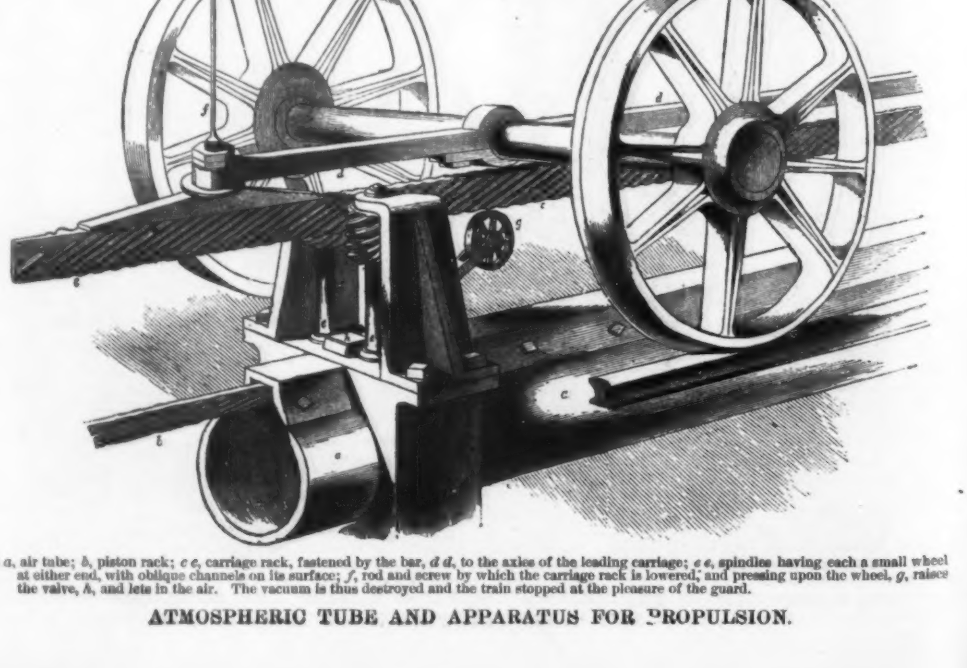


THE ATMOSPHERIC RAILWAY.



a a, the vacuum tube; *b*, chamber in which the piston rack, *c*, moves; *d d*, piston; *e e*, spindles; *f f*, carriage rack.

SECTION OF THE VACUUM TUBE, PISTON, AND SPINDLES.



a a, air tube; *b*, piston rack; *c c*, carriage rack, fastened by the bar, *d d*, to the axles of the leading carriage; *e e*, spindles having each a small wheel at either end, with oblique channels on its surface; *f*, rod and screw by which the carriage rack is lowered, and pressing upon the wheel, *g*, raises the valve, *h*, and lets in the air. The vacuum is thus destroyed and the train stopped at the pleasure of the guard.

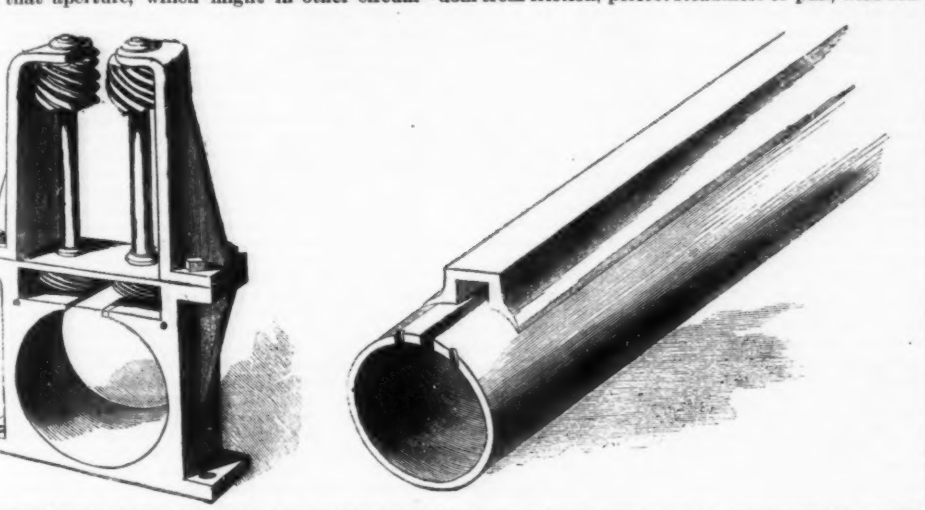
ATMOSPHERIC TUBE AND APPARATUS FOR PROPULSION.

of these wheels enter the chamber above the piston. Into the tube the piston is placed, carrying with it the bar, or piston rack, in the square chamber above. The progress of the piston brings the rack between the edges of the spindle wheels, and turns the spindle round with great velocity. This description relates to all that is under the surface of the road midway between the rails.

Above the surface of the road are the media of connection with the moving power. The spindles have wheels at the top in every respect corresponding with those which enter the chamber below. Along the center of the leading carriage there is placed a rack, in shape and form, only rather wider, similar to the piston rack. This rack is of sufficient length to be in two pairs or pinions or spindles at the same time, and by consequence it is never out of gear during the whole time the propulsion apparatus is acting on the carriage.

After a close examination of the apparatus, there are some delicate arrangements which may escape the attention of those who have not addicted themselves to practical science, and yet know enough of theoretical science to anticipate difficulties. Every one who knows the first elements of pneumatics understands that the pressure of the atmosphere on a vessel from which the air has been removed is exceedingly great—in exact ratio to the surface exposed. With much truth it may be said, If a vacuum be produced beneath the spindles, must not the pressure be so very great as to resist the piston rack, or at least occasion a degree of friction which must be ruinous? Admitted; the premises are sound, and the conclusion implied in the inquiry is correct. But the piston is so adjusted as to be a little in advance of the piston rack, so that the piston passes under the spindles, and destroys *in loco* the vacuum; the equilibrium being restored, the piston rack, therefore, has not to contend with the superpressure of the external atmosphere.

Another difficulty is also prevented by this arrangement. As the spindles are slightly raised by the passing of the piston rack, it might, on a *prima facie* view, be supposed that leakage would be occasioned. From the fact above stated, the air is not admitted until the piston has passed, and the air rushing in behind the piston, that aperture, which might in other circumstances be the cause of leakage, is the admission of fresh air adding impetus to the piston.



VACUUM TUBE AND A PAIR OF SPINDLES, THE FORMER SEEN IN CONNECTION WITH THE SMALL SQUARE BOX AND THE LATTER INCLOSED IN ITS BOX.

In practical working on the usual scale, with the broad or narrow gauge, the spindles will be placed at intervals of thirty feet.

The tube is not exhausted directly, but by means of a pipe connecting it with a receiver of an adequate size. The receiver is exhausted by an engine pump, and when the mercury rises to twenty-two degrees, the vacuum is found sufficient for practical purposes. When the receiver is exhausted, the top of the connecting pipe is turned, which occasions all the air in the tube to rush into the receiver; the atmosphere then presses on the surface of the piston and propels it with great velocity. This remark applies exclusively to the model now at work at the Adelaide Gallery. In practical working, the exhausting engines will be placed at intervals of ten miles.

THE STEAM TURBINE.

By JAMES ASHER.

MORE than two thousand years ago Hero of Alexandria, Egypt, obtained circular motion by leading steam through a hollow shaft into a globe and exhausting the steam through two tubes which directed it backward at the circumference. The unbalanced pressure of the escaping steam caused the rotation of the turbine. A few inventors have recently brought into use similar turbines, in which the rotary motion is produced by the escape of steam. The sword engine takes steam through a hollow shaft and exhausts it near the ends of two diametrically opposite hollow blades, which are sharp on their forward edges, to cleave the exhaust steam. The enormous speed of these blades in the exhaust steam greatly reduces the power. A casing surrounding the turbine directs the steam into the exhaust pipe. Ruthven, of Edinburgh, and Avery, in the United States, invented steam turbines. Such were used in Scotland in the beginning of this century to drive saw mills. They were almost as economical of steam as piston engines of the time.

Mr. Parsons, in England, has invented a turbine which gives almost the highest economy of steam ever attained by any steam engine. This turbine consists in seven wheels on one shaft, each having five rings of blades through which steam passes in succession. These little blades are set at an angle. After the steam passes through each set of blades it is directed against the next set by stationary blades slanting in the opposite direction. On reaching the edge of the wheel the steam enters another wheel near the center. It traverses this in the same way until it reaches the circumference, and so on in succession through seven wheels. The wheels are all 15 in. in diameter, except the last, which is 26¾ in. in diameter. This wheel has blades on both sides. A revolving baffle piston, opposite the wheels, prevents end thrust on the shaft. Steam of 100 lb. by gauge was used. There was a condenser; the steam was superheated, and the turbine ran at 4,800 revolutions a minute. It was directly coupled to an alternating current dynamo and gave 179 indicated horse power, requiring only 15·1 lb. of feed water per indicated horse power hour. It was tested by Prof. Ewing.

"There is nothing in the construction or work of the turbine to make superheated steam attended by the drawbacks of other engines of the old type. The steam works without lubrication, and comes in contact with no rubbing surfaces, and there is no packing to be injured." One of Mr. Parsons' turbines drove a dynamo supplying 159 incandescent lamps. "Only 92 failed in two years; the remainder ran 6,500 hours. Had the lamps run only 1,000 hours, as is usual, their cost would have been double the cost of the fuel." The perfect steadiness of motion caused the long life of the lamps.

Mr. J. H. Dow, of Cleveland, O., has invented a steam turbine somewhat similar to Mr. Parsons'. It has an equal number of steam wheels on each side of the end of the steam pipe. In his earlier turbine there were only two wheels, one on each side. These wheels are keyed to the same shaft. The steam, having done its work, escapes into the casing, then into the exhaust pipe. The wheels are of aluminum bronze and are 5½ in. in diameter.

The turbine complete weighs 68 pounds. The steam pressure was 70 pounds to the square inch. The turbine gave 10 horse power. The steam required was 47 pounds per horse power hour. The turbine drove a dynamo running 13 arc lamps. The speed was about 16,000 revolutions a minute. The advantages claimed for this turbine are "extreme simplicity, compactness, lightness, cheapness, freedom from friction, perfect steadiness of pull, with consequent smoothness of action, extraordinary storage of power in momentum of steam wheels, about 10,000 foot pounds, giving unusual steadiness under sudden changes of load. No part is subject to alternate heating and cooling, and expansion may produce better results. It may use the highest steam pressures with advantage."

Any steam turbine must be driven at an enormous speed, approaching the velocity of the steam, to obtain economy. Very high pressure steam is of advantage, for it flows very little faster than steam of much lower pressure, and we can use a smaller engine. We can have greater economy of steam, because the temperature difference between initial and exhaust steam is greater. For driving slow speed machinery we would use belting to speed down.

For generating steam of very great pressure the water tube boiler is the safest and best. The Babcock & Wilcox boiler in some cases has worked with 500 pounds to the square inch. It would be of interest to connect a most carefully constructed steam turbine with a boiler bearing a steam pressure of 500 pounds to the square inch. The horse power hour could probably be obtained with 10 pounds of feed water in a 100 horse power engine.

The steam turbine need not cost one-fourth as much as the piston engine. The economy in steam is shown by the test of Mr. Parsons' turbine to be almost the highest ever obtained by any engine and probably the very highest ever obtained by an engine of equal power. There is no friction except at the two bearings, and graphite may be used here instead of oil; the very highest steam pressures may be used with great advantage and without injuring the lubrication. There are neither valves nor packing. There are no dead centers; hence the turbine will start without help, and the pull is absolutely uniform at all points of the revolution. No flywheel is needed, for the speed is so high that the mass of the turbine itself gives great storage of energy. High speed machinery, as dynamos, planers, blowers, and rotary pumps, can be coupled directly to the turbine, needing neither belting nor gearing. The floor space occupied is exceedingly small. A turbine of 100 horse power need take up no more space than a common grindstone. Superheated steam can be used with advantage, for there is no packing, and the steam never touches the lubricant. A turbine of 1,000 horse power will not be much larger than one of 100 horse power, and will not cost twice as much. The cost of foundation will be very low. Only two places need lubrication. Priming cannot ruin the turbine.

The piston engine is an engineering barbarism. It takes steam which can flow at the rate of ten miles a minute, and uses it in driving a slow, cumbrous piston; it has cylinder, steam chest, piston rod, connecting rod, guides, gibs, keys, rings, the absurd jerky crank, eccentrics, triggers, valves, springs, dashpots, weights, balls and pet cocks, flywheel, and sometimes a large wheel on the shaft for governor with large springs, heavy weights, an additional eccentric, valve and valve rods. There are dozens of places needing oil. There is a very heavy iron base on a large, costly foundation. Then there is a heavy, costly belt. Its weight causes great strain on the bearings of the engine and the machine which it drives; when driving by countershafting the strain is twice repeated. At last, in the case of driving a dynamo, a speed is reached at the circumference of the armature which compares with the speed which the steam might have had in doing the work directly.

Mr. Nikola Tesla, the brilliant electrician, "the man of the hour," says of the turbine: "Though I am aware that the majority of engineers do not favor their adoption, I do not hesitate to say that I believe in their success. No matter how much one may be opposed to the introduction of the turbine, he must have watched with surprise the development of this curious branch of industry in which Mr. Parsons has been a pioneer, and every one must wish him the success his skill had deserved."

Canboro, Ont., Canada, August 12, 1893.

A VISIT TO A SHEEP DIP FACTORY.

AT the invitation of Messrs. Wm. Cooper & Nephews, of Berkhamsted, a representative of *The Chemist and Druggist* took the train to the little Hertfordshire town the other day to inspect the works of the great sheep dip manufacturing house, which has just celebrated the fiftieth anniversary of its foundation.

Berkhamsted is situated in a pleasant valley surrounded by wood-clad hills, and the line from Euston runs through some of the nicest country to be found in Southern England. Unfortunately the beauty of the view is poached upon in many of the most picturesque parts by unlovely advertising boards on which the traveler is admonished to strengthen his liver, his teeth, his blood, and his anatomy generally, by partaking freely of the remedies advertised in the brightest pigments that the world produces.

Our representative was received at the office of the firm by the manager of the works, who was busily engaged in looking over a batch of letters that had arrived by the morning's post from Australia and South America.

"See here," said that gentleman, showing a letter from the firm's Buenos Ayres agents which he had just read through, "here is remittance for one month's trading, two drafts, amounting together to rather over £5,000. That is not so bad for a depressed country like Argentina, is it?" And, excusing himself, the manager momentarily disappeared into the general office, to give some instructions to the staff before guiding his visitor through the works, and leaving the latter, in the meantime, to admire the designs for two prize cups which Messrs. Cooper & Nephews propose to award to the owners of the two Cotswold rams that shall be declared winners at a certain live-stock show in connection with the Chicago Exposition. When our representative had done with the sketches, he looked around the place, which was strangely unlike most chemical works offices with which he is acquainted. The room in which he stood was almost in the center of the works, but beyond the muffled and monotonous throb of a heavy steam engine in a neighboring building, and a few small patches of a deep yellow powder upon the roadway, there was nothing whatever to indicate the proximity of some two hundred men busily mixing tons of sulphur, arsenic, and other ingredients. Adjoining the office was a neat vinery, and a short distance beyond, near a dwelling house forming part of the works, our representative had noticed, in passing, a lovely terrace and lawn, fringed with rosebushes in full bloom, everything clean, fresh, and as unlike Battersea, the Borough, or other typical metropolitan manufacturing districts as a soft-fleeced, plump, Cooper-dipped sheep is different from its vermin-infested, neglected cousin, owned by some barbaric herdsman.

Presently the manager returned, and, again referring to the morning's mail from Buenos Ayres, read aloud a letter from the agents for Argentina, giving the names of eight or ten of the largest sheep owners in the country who had forwarded exhibits of the Argentine wool industry to the States. "It may interest you," added the agent, "that all the wool raised by these farmers is Cooper-dipped."

As we set out on our walk, the manager gave us reminiscences of old Mr. William Cooper, the founder of the firm, who has now been dead some ten or twelve years, and at whose decease the business came into the hands of his three nephews, one of whom has also since died.

"The founder of our house," he began, "was a veterinary surgeon, in practice at Berkhamsted, and a very good practice he had. His house stood there at the entrance of the works, just opposite the building with the royal coat of arms, and his veterinary surgery was in the little place at your left. In 1843, just fifty years ago, Mr Wm. Cooper, who had paid a great deal of attention to the diseases of sheep, then exceedingly virulent, hit upon the idea of the remedy now known all over the world as Cooper's powder."

"What did they do before?" we inquired. "Surely, in some form or another sheep-dipping must be centuries old. Do you think that the gentle Una in the 'Faery Queene,' for instance, of whom we are told that 'by her, in a line, a milk white lambe she lad,' did not dip the creature? A scab-infested lamb is hardly a subject for poetic allegory."

"Certain modes of treatment may have existed, but until Mr. Cooper came, dipping was practically unknown. The most progressive farmers smeared their sheep with an extract of tobacco, or used crude carbolic acid, and other remedies which either failed to kill the insects with which the sheep are infested, or else attacked the wool, discoloring and otherwise de-

preciating it." Mr. Cooper, we learned, set himself to discover a remedy which should not only be a cure, but a preventive at the same time, which would eradicate the scab disease and kill the ticks and lice that batten on the helpless mutton, and of which grewsome insects enlarged representations bedeck the walls of the Berkhamsted office. The result was the "Cooper's dipping powder," which is even to-day the one and the only article manufactured at the works, and in which, as you may read in the polyglot advertisements of the firm, over one hundred millions of sheep in all parts of the globe are now bathed every year. Mr. William Cooper is said to have spent many months in experimenting, and when at last he was satisfied with the article he had produced, he commenced in quite a small way to manufacture it in a shed adjoining his premises.

We do not know whether the Messrs. Cooper preserve the original formula of their powder, as the genuine Farina is said to do that of his eau de Cologne, in a treble crystal vase standing solitary on a pedestal in an otherwise bare apartment; but they certainly guard the composition, or rather the mode of preparation (for the chief ingredients are too bulky to admit of secrecy) with the utmost care, and they have up to the present succeeded in eluding all the pitfalls dug for them by rival makers with the object of becoming possessed of the knowledge of the manipulations.

"I suppose," said our man to his cicerone, "that in the course of half a century you have effected important improvements and modifications in the preparation of your dip?"

"Not a bit of it," was the answer. "The powder of which you will witness some of the manufacturing processes to-day is absolutely the same in every respect as the first batch which the late Mr. William Cooper succeeded in selling. That is our boast. We claim that the old gentleman invented a powder which was absolutely incapable of improvement, and no alteration whatever has been made in the manufacture; not so much as a drachm to the ton of ingredients is different now from what it used to be."

"But, surely, in the course of your business experience you have added other articles of a similar character to the powder manufacture. One would imagine such a business as yours to be capable of evolution in many directions."

"It may be so capable, but we have never tried it. Dipping powder is, as it has always been, our one and only article of manufacture. It is powder, the best powder, and nothing but the powder. Stay—some years ago we went in experimentally for the manufacture of a wheat dressing, but we soon relinquished that, and we have never tried anything else. The two hundred men or thereabout whom we employ are all engaged upon work incidental to the production and sale of this one article, as you will see. But we do almost everything here that is connected with the manufacture of the dip. We do our own printing, make our own boxes, and even this little steam engine has been entirely manufactured in our engineering shop. When we want to modernize or extend our works (and we are always engaged upon the one or other occupation) our own men do the work, from the first brick to the last tile, and what energy we have to spare we devote to the devising of appliances and the working out of ideas that will help the farmers to improve their stock, and assist the sale of our dip at the same time."

"I notice that your export business is very extensive. Can you tell me roughly what proportion it bears to your home trade?"

"Hardly, except that we export several times as much as we sell at home. We send, perhaps, ten thousand cases out of the country every year. In the United Kingdom we sell through chemists only. There are from two thousand five hundred to three thousand of these now selling our dip as agents. In the Colonies and abroad we have either branch houses of our own or sole agents with whom alone we have direct dealings. Hence, though our export trade is so much larger than our home business it gives us much less trouble and correspondence. We keep registers, as nearly complete as possible, of all the farmers in the United Kingdom, and we circularize these actual or potential customers periodically. Where we have an agent we print his name on the labels. Just now, as you will see when we get to our printing department, we are up to our ears in the production and distribution of our jubilee book, of which a copy will be mailed free to every farmer upon our register. See, there is a cartful just going out."

And our friend pointed to a cart loaded to the top with bundles of the "jubilee book" aforesaid, apparently on the principle of the Dickensian holiday makers at Greenwich fair, with whom the question was not what the horse could draw, but what the vehicle would hold. When the manager perceived this state of things, he ordered the overflow to be placed upon a handcart, and both went gayly rolling off to the Berkhamsted post office, after having been photographed for the occasion.

Thus conversing, we had visited several of the sheds devoted to the preparation of the powder. First a roomful of what looked like pearl-ash; then a shed, in which a huge pulverizing mill was busy in grinding a mixture in which sulphur appeared to be the principal constituent; and, finally, a yard stacked and strewn with kegs of white arsenic powder.

"We buy our arsenic in lots of five hundred tons at the time," said the manager. "It all comes from the Cornish tin mines."

"Do you take any special precautions with it?"

"No; we cannot. Of course all our hands know of its danger, but the quantity we use is far too large to enable us to keep it under lock and key, or to prohibit any but a few workers from having access to it. Still, the men are very careful, and so far from the handling of it having any bad effect upon them, you will see that they all look in the best of health, and many have been with us for years. In some of the sheds the men work with mufflers round their mouths, and in all of them we recommend them to plug their nostrils with cotton-wool."

"What do you do with the empty casks?"

"Sell them for packing nails in, and so forth. But we never send them out of the place without thoroughly washing them beforehand, and we have never heard of any trouble having arisen through their handling."

We had now reached the wharf at the end of the works stretching along the Grand Junction canal, which places the works in direct communication with the chief centers of industry in England. Behind us was an alkali shed in which were stacked many hundreds of barrels of potash salt.

"We get our brimstone directly from Sicily," was our guide's observation.

"Do you ever use the English recovered sulphur?"

"No; we have never tried it, and we don't want to, either. It would not pay us. We make no change in the price of our dip when the raw materials fall in value. Of course, as you suggest, we have been fortunate lately in obtaining much of our raw material at very low prices. Sulphur is cheap, certainly. But look at arsenic. We used to get all we wanted at nine pounds a ton, and now we have to pay nearly twenty-five per cent. more. Coal has also risen. No; we don't raise our price when the raw materials advance, and so we are entitled to the benefit of low rates."

"I suppose most of your goods are sent by water?"

"Certainly, seeing that water carriage is much the cheapest. We have not suffered from the railway rates increases though. The company put up their tariff for our goods, but we protested successfully, and the charges are now, if anything, lower than they were before."

"This," said the manager, pointing to a stack of boxes ready for shipment, in one of the sheds, "is a consignment of our dip about to be sent to Australia. There are over a million sheep there. All through the works the stock of dip ready for shipment is reckoned by millions, or fraction of millions of sheep. These boxes weigh one hundred and twenty-five pounds gross, and each one will dip two thousand sheep. We don't put up our Australian dip in the small one and one-fourth pound packets in which we pack it for home consumption. Your Australian herdsman, with his quarter of a million of sheep to wash in the busy season (they dip them there straight off the shears), would not thank us for giving him the trouble of undoing thousands of little packets. They are much more practical in these matters in the Colonies than they are here.

"Your British farmer will fill a small single sheep bath with his dip, plunge in one sheep at a time and bathe him by the aid of four men. Ninety-nine per cent. of the British flocks are so dipped. In Australia they drive the sheep by hundreds into a large pen with a narrow exit through which one after another they pass into a long bath with slanting bottom, consisting of a trench about sixty feet long, dug in the ground, with a bricked floor, and about five feet deep at its greatest depth. From five to seven sheep pass through the water at the same time, and, as they lose their foothold, constantly stir up the dip with their feet, so that they get thoroughly soaked with it, and don't require another bath for a twelvemonth. Three men can dip hundreds. In Britain we recommend dipping twice a year. The dipping season here is just coming on now, and we are therefore at this moment busier than usual."

Thus talking, we passed from shed to shed stacked with stock ready for shipment. "There is enough stock upon the premises," broke in the manager, "to dip twenty-five million—wait a bit; no, fifty million—of sheep, but all we make is moving off fast enough. Our principal customers abroad are Australasia, the United States, South Africa, and Argentina. On the Continent we don't do very much, excepting in Russia, where we have a fair trade, though nothing like what it might be if the farmers were more progressive. Here is a consignment for Russia," and he pointed to another stack of boxes with Russian labels. "Germany and France are very backward in the matter of dipping.

"You would think a country like Germany would be in the van in such a matter; but no, most of the farmers there don't dip at all, and nearly all are addicted to the fatal custom of penning up their flocks at night under a closed roof, which certainly does not tend to make the sheep any healthier. In Spain they have the finest sheep in the world. The merino is such a good breed that even in the absence of dipping its wool commands as high a price as any variety, and I am afraid it will be many years before we shall be able to convert the Spaniards to our views. And yet if they only knew the advantages of dipping, how they would blame themselves for having neglected the practice so long. We reckon that the average cost of our dip is a halfpenny a bath, or a penny a year where sheep are dipped twice. An outlay of a shilling packet for every twenty-five sheep is ample. But consider the gain. We always analyze the prices realized at the London wool sales, and we find that, as a general rule, the wool from Cooper-dipped estates brings the best prices.

"We are not very much hampered by protective duties abroad. In the States, when the McKinley Bill was under discussion, the farmers actually petitioned Congress to remove the duty on sheep dips altogether, and their efforts were successful to this extent that the rate was reduced by fifty per cent. But we are only moderately thankful to Mr. McKinley, for had it not been for him, dips would certainly have been put on the free list. In Australia also the tariffs are not adverse to us. Although there is no scab in the Australian colonies—it has been stamped out by vigorous legislation, and only occurs very sporadically in Western Australia—nearly every sheep farmer there dips as a preventive against vermin, and they must have dip at any cost.

"Spanish and Dutch are the two foreign languages in which we send out our pamphlets and advertising matter. Dutch is very important to us, owing to the large Dutch sheep-farming element in Cape Colony and the two republics, where the Dutchmen take very kindly to the dip.

"In England we are doing all we can to educate farmers up to a better system of dipping their sheep. We make a large number of dipping baths here" (we were now in the carpenters' shop) "and keep a considerable number of men at work in this department. We use Swedish wood, and every bit of it is seasoned in our works for two years before it is used. We have just patented a new bath—you will see a specimen of it there in the yard—a metal one, wedge-shaped, to be sunk into the ground. The animal is taken from its pen down the inclined plane into the dip, and the trap door closed upon it by means of a lever. When the sheep has stirred about sufficiently, the door is drawn back by another movement of the lever and the operation is performed. This does away with a lot of manual labor."

Then, reverting again to the question of the chemists' business in the dip, Mr. Gilbert told us that during the last three years the firm had insisted upon having from every one of their customers a signed declaration binding the buyer not to cut the price. Until this scheme was introduced Cooper's dip was cut by rival dealers to their hearts' content; now underselling is a thing of the past. Of course, the circumstance that the works are in direct relationship with all their customers in this country renders it much more easy to control the sales than if the bulk of the business were done through wholesale houses.

From the carpenters' shop we went to another part of the works, known as the artistic and printing department. On the way thither a large building was visited, devoted to the putting up of the dip. In a room below a dozen men, all sprinkled with yellow powder and swaddled in protecting clothes up to the eyes, were busily engaged in shoveling the powder from the flat trays on which it was carried into the room into rough packages. These were taken to the floor above and there neatly finished and labeled by youths, who put them on boards containing a dozen each and stacked them on the rack behind.

"Don't you employ any female labor at the works?" asked our representative; "they say women are much defter at this kind of work than men."

"None at all. It is an old tradition to which we strictly adhere, that only men shall be employed about the factory. Besides, labor is cheap here. This youth gets a penny for every six dozen he puts up. How many boards did you put in last Friday, my lad?"

"Sixty-six, sir," came the answer.

"That would make elevenpence for the day?" queried our man.

"Yes; but then part of the day was spent in other work. Had he been at this job all day long, he could have put up at least one hundred and thirty boards. We work ten and one-half hours a day here."

The next move was to the printing office, where two fine "Climax" presses were hard at work turning out copies of the "Jubilee-book," while lithographic stones in various parts of the building testified to the importance of colored show-cards as factors in the "publicity department" of the house. "We have just brought out a fine advertising card," said the manager, holding up a reproduction of W. Hunt's "To the Rescue"—a big dog pulling a lamb out of the water, the mother standing by with tears of gratitude in her ovine eyes. The dog had the words "Cooper's Dip" on his collar, and another reference to the preparation adorned the clouds in the background. I suppose, thought our man, the time may not be far distant when R. A.'s shall paint exclusively for our large advertisers. The tendency to paint subjects that lend themselves for advertising purposes seems distinctly on the increase.

"When Mr. Cooper first started business," our guide again took up the tale, "all our printing was done by hand-presses. It has always been our boast that our works are self-contained, and no advertisement, label or hand-bill was ever issued by Cooper's that was not actually printed here."

Enameled iron sheep in various attitudes gazed down upon us from all the walls of the room. "A Black-face Scotch," "A Shropshire," "A Leicester Ram," "A Romney Marsh," and so on through the whole range of sheepdom. Presently we were introduced to the gentleman who is the author of all these creatures, and whose proud boast it is that he has spent over thirty years of his life painting nothing but sheep for Cooper's Dip. "Our artist here knows sheep better than any man in the world; his creations in sheep are simply perfection. I verily don't believe there is any painter in the world, not even Sydney Cooper, can touch him in this department." So ran the encomiums upon the painter. Three hundred iron enameled merinos are ready to be sent to Buenos Ayres by the next steamer. A picture of the works, 20 feet long, has just been sent off to Chicago by the firm, and the clay model from which it was reproduced stood on a table hard by.

"We bring out a new poster at least once a year," the artist said, "and we are continually getting up books of information on sheep-breeding for the benefit of farmers. Our Mr. Cooper, the surviving partner, who is himself an M.R.C.V.S., has a large estate at Shenstone, where he breeds some of the finest sheep in Britain. He can, therefore, speak with authority on the subject, and whatever knowledge he acquires in this line we make useful to the business.

"Time to go? Well, you have not seen a fifth part of the works yet, although, to be sure, if I were to take you through the remainder you would only witness a repetition of the same processes you have already seen. So we will leave it there. But I might tell you this as a parting impression, each 1¼ lb. packet (of which there are seventy-two in an ordinary box for the home trade) will make 16 gallons of dip, and treat fifty sheep. We have always a stock on the premises large enough to dip fifty millions of sheep. So now you can readily calculate the number of boxes we have here awaiting shipment at a moment's notice. And we are a very happy family here. There has never been a strike or other serious trouble at our works.

"Our men have several clubs and societies to which the proprietors of the firm give their support, and all work harmoniously together for the benefit of the powder. There must be quite a thousand people in this little town dependent, directly or indirectly, upon Cooper's, and you may judge for yourself if it is likely that, without our factory, Berkhamsted would stand where she does."

COLORING PAPER ON ONE SIDE

CONSISTS in passing the paper, when sufficiently dry to allow its being transferred without a felt, through a bath of the color which it is desired to impart to the paper. In order to avoid the color penetrating through the paper to the side which does not require coloring, it is necessary that the contact with the bath should be constant and regular.

In its passage through the machine the paper passes

between drying cylinders, and when the paper is sufficiently dry to prevent all fear of the color running, the paper is ready for the color bath. In certain cases, however, it will be possible to place the color bath directly after the first drying cylinder.

The vessel containing the coloring matter is placed under the paper as it passes through the machine. As the paper is tightly stretched, it is necessary to pass it under rollers so as to bring the side which requires coloring in contact with the surface of the liquid in the bath. To do this three roller guides are used, arranged so that the lowest of the three just brings the paper on to the level of the bath. As during the process of staining the paper the level of the solution in the bath is constantly becoming lower, it is necessary to adopt some means of keeping the solution at a uniform height. The best method of doing so is to allow more of the coloring solution than experience has shown to be necessary to steadily enter the bath, and to fit an overflow pipe to carry off the excess, and so maintain a constant level. The chief advantage about this process is the ease and rapidity with which different colors can be employed, all that need be done being to change the bath through which the paper is passed, which can be done at will, and without stopping the machine.

THE COTTON-SEED OIL INDUSTRY.

SINCE history began her unending labors, no vegetable product has ever become as suddenly and universally popular as cotton-seed oil. Only a few years ago it was among the things undreamed of; now it forms a part of nearly one-fourth of the manufactured articles the housekeeper purchases of her grocer.

Unfortunately, cotton-seed oil "gums" very easily, and this renders it useless as a lubricator, but for table use, cooking purposes and as a miner's oil it has no competitor which can claim entire superiority.

As a miner's oil it is particularly valuable, as it is as non-volatile as lard or grease.

The experiment of throwing lighted matches into barrels of this oil has often been tried. In every case the matches ceased to burn as soon as the wood in them had been consumed. Like every other oil, cotton-seed oil will burn when heated to a very high temperature, but it has never been known to explode.

As a table oil some palates prefer cotton-seed oil to sweet oil, and when the packing houses of the country extract all of the oil from their lard they have a very small percentage of material with which to do business.

So common is the custom of adulterating lard and butterine with cotton-seed oil that very few packing houses consider it necessary to make any secret about the matter. There seems to be no real reason why the fact should be kept secret, as the cotton-seed oil is said to improve the lard rather than detract from its quality. Whether this is so or not, the fact remains that a great deal of the lard on the market at the present day is made up of cotton-seed oil and other more harmful adulterations. The higher the price the factories charge for a brand, the fewer adulterations are to be found in said brand; the lower the price, the more numerous the adulterants.

Another article in which cotton-seed enters largely is soap. In Cincinnati the amount of cotton-seed oil used for this purpose is very much greater than for any other article which is manufactured here.

Proctor & Gamble have a large number of tank cars in which they haul cotton-seed oil from the crude mills in the South to their factory at Ivorydale, where they refine the oil. Several of the other soap factories use cotton-seed oil in the same manner, but not to such an extensive degree.

The tank cars used hold an average of 140 barrels each and are kept pretty busy during the oil season. The vast amount of cotton-seed oil which is yearly consumed in Cincinnati cannot be accurately estimated. Some idea, however, can be arrived at when it is considered that in the manufacture of soap alone 20,000 barrels are used here annually. Add to this an almost equally large amount which is used to supply the lamps used in the brewery cellars. Bakeries here are daily growing to favor the use of cotton-seed oil for the cooking of many sorts of cakes, doughnuts, etc. Private families have, in some sections of the city, become fond of the taste of cotton-seed oil and say that they prefer it to the sweet oils formerly so popular with the republic.

The American Cotton-Seed Oil Company manufactures yearly in the neighborhood of 600,000 barrels of this oil, and is always able to find good sales for its product. The Cincinnati branch of the American Cotton-Seed Oil Company has always more than cleared the shoals of commercial embarrassment and has always found a safe port when storms were brewing on the usually smooth surface of oil.

The past season has been a somewhat remarkable one in the cotton-oil year. It opened with a very cloudy appearance. "Poor prices" seemed to be stamped upon the heavens, but as the weeks passed by the prices improved until now nearly all of the oil has been sold by the Southern mills at very fair prices. The last few days have shown a decided falling off in cotton oil prices, but as most of the oil is now held by manufacturers, who do not care, or by dealers who are able to wait calmly for better prices, the situation is by no means a desperate one.

At present, reliable advices from New York are to the effect that the cotton-seed oil situation is dull. There is some inquiry from exporters, but the prices offered are very low. The market, in short, may be said to be in a nominal position. Prime crude is quoted at 36 to 37c.; prime "summer yellow" at 42 to 43c.

Nearly all the miners' oil used in this State is cotton-seed oil, and the average mine owner or coal operator refuses to let any other sort of oil be used by his men. This is because its non-explosiveness has been so thoroughly and indisputably tested.

"An interesting thing about cotton-seed oil," said an official of the American Cotton-Seed Oil Company, "is that there is no estimating exactly where its usefulness will stop. We get letters every day from people in different parts of the United States asking us all sorts of queer questions concerning cotton-seed oil and its peculiar characteristics. Very frequently they refuse to let us know for what purpose they want to employ the oil, and this always gets our curiosity aroused to a white heat. Some time ago a man in the East nearly put us in the asylum by the peculiar letters he sent us by nearly every mail. He used blank letterheads, and there was no way in which we could at first see our way to discovering his purpose with the oil.

"Finally, we wrote to some other business men in the city from which the letters came, and asked them to let us know our questioner's line of business. What was our surprise to learn that he manufactured the sticky fly paper which you have noticed in restaurants and drug stores.

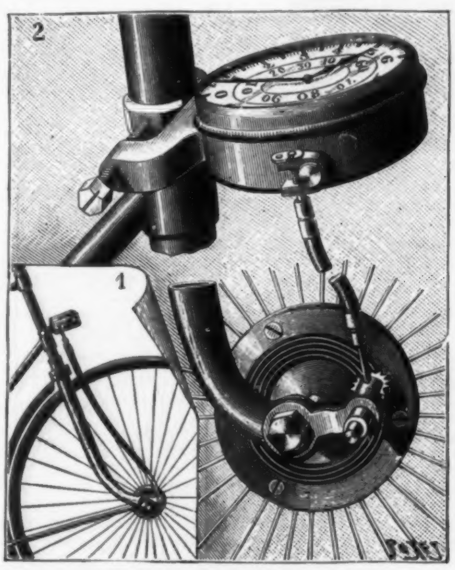
"I was informed the other day that a gentleman in Charleston, S. C., has discovered a way in which a substance very much resembling India rubber can be made out of cotton-seed oil. The new discovery will, if found practical, be of a decidedly revolutionary character, both in the oil business and in the India rubber market. Scarcely a day passes without some new discovery as to the availability of cotton-seed oil to meet some need of modern civilization being made. I should not be surprised to hear of their making shoe leather, car wheels or sailing vessels out of it. During the natural course of American events all things are probable."—*Cincinnati Times-Star.*

COUNTER OF DISTANCES FOR BICYCLES.

ONE of the points that most interests the bicyclist is that of knowing the distance traveled from his starting point, and which permits him, through a very simple calculation, to foretell approximately the time of his arrival or to give himself up to the most varied meditations upon the value of his endurance. A large number of apparatus have been devised for the solution of this problem. The one that we are going to make known to our readers seems to us to furnish a very elegant, simple and general solution.

The essential characteristic of Mr. Couleru-Meuri's system is its facility of adaptation to a vehicle whose wheel has any diameter whatever included between 50 centimeters and 2 meters, and of adjustment with an almost illimitable precision.

The counter consists of two distinct parts connected by a flexible shaft of a length equal to the distance



COULERU-MEURI'S COUNTER OF DISTANCES FOR BICYCLES.

1. Mounting of the device upon the front wheel. 2. Details of the actuating mechanism.

that separates the axis of the bicycle from the point where the dial must be placed in order that it may be easily consulted at any instant by the cyclist.

The mounting, as a whole, is represented in No. 1 of the accompanying figure, and the external aspect of the two parts, on a larger scale, in No. 2 of the figure. The actuating device consists of a disk fixed to the steering wheel by means of three screws and of a collar. The disk is provided with a triangular groove in the form of a spiral, in which engage the fifteen teeth of the same form of a small wheel, so that its axis makes one revolution to fifteen revolutions of the steering wheel. This toothed wheel is mounted upon an arm fixed upon the axis of the steering wheel upon the right side of the fork that supports the latter. Its axis actuates another Stow flexible shaft analogous to those so frequently used at present by dentists. The other extremity of the flexible shaft is fixed to the extremity of an endless screw mounted upon the side of the cylindrical box forming the counter properly so called. This box, which is 6 centimeters in diameter and 25 millimeters in thickness, contains the mechanism that transmits the rotary motion of the flexible shaft to the hands. It is in the method of transmission that resides all the novelty of the system. To this effect, the endless screw actuates a horizontal axis through the aid of a wheel provided with 30 teeth, the axis of which, therefore, makes one entire revolution to $30 \times 15 = 450$ revolutins of the driving wheel. The hands are moved through a horizontal disk with which they are connected and a roller mounted upon the internal axis of the counter. On regulating the distance of the roller from the axis of the disk, we modify at will the ratio of the angular velocities of the two parts, and it is, consequently, easy, through a preliminary regulation, to adapt the positions of the roller for which the readings of the counter correspond to the distances really traversed by wheels of such or such a diameter.

An index that emerges from the box permits of adjusting the apparatus to the diameter of the wheel. Such adjustment is afterward completed by maneuvering a small regulating screw in the direction of fast and slow, according as the readings of the apparatus are in advance of or behind the distances really traveled.

The putting back to zero is effected by pressing a button situated at the lower part of the counter. Such pressure momentarily separates the roller from the disk that moves the hands, which latter become free, and are then capable of being moved back to zero by turning the very button that has served to render them independent.

The dial carries two hands, the shorter of which marks the myriameters, and the longer indicates the kilometers and hektometers, and permits of estimating the distance traveled to within about 50 meters. The weight of the complete apparatus does not exceed 400 grammes, and this permits of its adaptation to a cycle without excessive supercharge.—*La Nature.*

WASHING POWDERS.

THE washing powders or soap powders which have latterly become important articles of commerce always contain besides powdered dried soap a large percentage of sodium carbonate, generally in the form of dried soda crystals. These powders may be prepared in either of the following ways:

(1.) Anhydrous sodium carbonate or soda ash is added to a "clear boiled" soap paste, and after thoroughly mixing, the somewhat stiff material is drawn off into cooling frames. The cold and hard soap thus obtained is then finely ground.

(2.) Soda crystals and soap are melted together and then treated in the above manner. This method of manufacture, however, is only advantageous where soap scraps are to be had.

A suitable apparatus consists of a wrought iron vessel with a strong agitator contained in an interior cast iron vessel, which can be cooled by water circulated in the outer vessel. The liquid soap is cooled while the soda ash is slowly added and completely dissolved. During the grinding process care has to be taken not to overheat and thus soften the product.

The composition of soap powders varies considerably. Only a small proportion of resin soap can be used, as such soap is sticky and cannot be powdered. Olein soap may be used with advantage, and the olein may be saponified with sodium carbonate instead of the more expensive caustic lyes.

As a small quantity of free chlorine is not objectionable in soap powder, dark colored materials, such as bone fat, fish oils, etc., may be used for making the soap, with an addition of a small quantity of bleaching powder.

To some soap powders 2 to 5 per cent. of sodium silicate is added.

A good washing powder should contain:
30—35 per cent. of fatty acid;
30—35 per cent. of sodium carbonate; and
30—40 per cent. of water.

The inferior powders containing only 5—10 per cent. of fatty acid should not be used for the laundry; they are only serviceable for scrubbing purposes.

There is a soap powder in the market containing a soap prepared by treating linseed with caustic soda directly. This soap contains certain impurities derived from the seed, which lather freely, and thus when the powder is used, give the impression of more genuine soap being contained in the powder than is actually the case. For washing printers' cliches and types a power is recommended containing only a small quantity of combined fatty acid, but 10—15 per cent. of caustic soda.

The so-called "bleaching soda" consists of 80 parts of soda crystals and 20 parts of silicate of soda.—*Chem. Zeitung.*

ABOUT LUMINOUS PAINT.

By J. E. SMITH.

NEARLY every one has heard of luminous paint—the sulphide of calcium—but it is probable that comparatively few persons know much about the behavior of this interesting compound.

When of good quality it is quite white as seen by reflected light, but the light that is emitted by it in the dark immediately after exposure to the direct rays of the sun is quite blue, and the emitted light is of a lavender hue directly after subjection to the action of ordinary diffused daylight. Both of these colors, however, in a dark room rapidly fade into a white light that is more luminous. A greater luminosity is produced by a short and near exposure to an ordinary artificial light, or by being placed near a window about sunset on a rainy day. The direct rays of a bright full moon falling on it for several minutes have very little effect, making it barely visible in a dark room.

After ten seconds exposure to good diffused daylight, which is as effective as an exposure of ten hours, this substance will give out a practical light for ten or twelve hours, and its luminosity will not entirely disappear in less than thirty hours. This great difference in the times required for the absorption and the emission of light is quite remarkable, and makes it seem as if the light emitted were many times greater than that absorbed.

When luminous paint of poor quality is removed from light to darkness the light emitted by it fades rapidly, and in a few minutes becomes of a dull reddish or smoky color, much like that of the moon during its total eclipse.

A temperature of 300° to 400° will not put calcium sulphide into a luminous condition, though after exposure to light an increase in temperature of 25° will make it much more luminous. That this is not a conversion of heat into light is shown by the fact that if kept at a high temperature it will become non-luminous in a shorter time. As might be expected, a lowering of temperature by ether or other volatile liquid will diminish the luminosity.

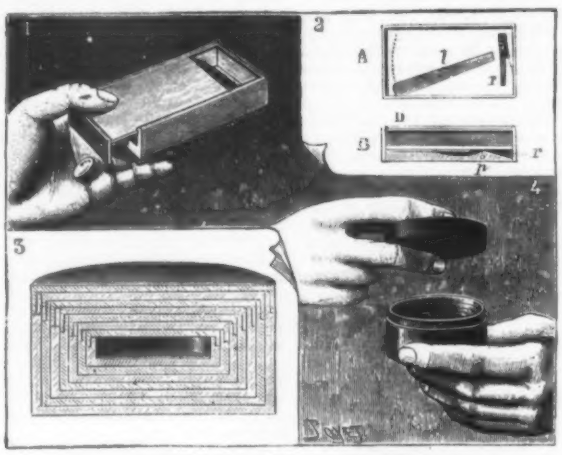
This luminous condition is not conveyed from particle to particle like heat. If a quantity of the dry powder be exposed to the light all day, on breaking through the surface the interior will be found to be non-luminous, the light having affected the outer portion to a depth of perhaps a sixty-fourth of an inch. If a bottle partly filled with the dry powder be revolved in the light until the whole mass has become luminous, and then be set away in the dark,

the interior loses its light as rapidly as the surface, but in doing so does not help the surface to glow any longer or more brightly. What becomes of the interior? Does it change into heat? Perhaps some physicist with facilities for delicate measurements can answer these questions. This non-conductivity of light admits of the production of some impressive effects. If the hand, with fingers spread, be held against a flat surface of luminous paint while exposed to the light, a black hand on a luminous field will be seen. If, however, the painted surface, while acted on by light, be well covered with a card having an opening the size and form of a hand, and then moved about in a dark room, nothing will be seen but a white, floating specter hand. Forms of various articles may be thus shown; but perhaps the most pleasing effect is produced by a piece of lace drawn tightly over the paint while in the light.

The luminous property of this substance is known to have remained unimpaired for more than five years.—*Chemical Trade Journal.*

DISAPPEARANCE OF A COIN.

A MARKED coin is placed in a rectangular box, whence it instantaneously passes into a round box which is not reached until seven or eight other boxes, inclosed one within another, have been opened in succession.



DISAPPEARANCE OF A COIN.

Fig. 1 shows how the coin drops from the box in which it was placed into the hand of the prestidigitator, under one of the end pieces which is adherent to the cover, and consequently leaves an opening when the latter is drawn out. The spectators, however, are persuaded that the coin is still in the box, since they think they hear it strike against the sides of it when the box is shaken, although the sound is really produced through the mechanism shown in Fig. 2. At A is seen the lower part of a first bottom; l is a strip of metal movable horizontally upon a vertical axis formed of a nail which traverses it very near one of its extremities, while the other extremity moves from one side to the other, according to the line indicated by dots in the figure, when the box is shaken from right to left and left to right; r is a spring designed to separate the corresponding part of the second bottom of the box, movable through a tilting motion upon a horizontal axis that separates it into two unequal parts in the direction of its length.

At B is seen a vertical section of the box and of the double bottom, which is not everywhere of the same thickness. Under such circumstances, through the action of the spring, the side of this second bottom bears against the strip of metal and renders it immovable, even when one shakes the box, which, for greater security, is then grasped in pressing the point, D, with the thumb, the other fingers being underneath. If, on the contrary, the box is held by the opposite side, and the fingers press in such a way as to bend the spring and slightly incline the double bottom, the strip of metal, set at liberty, produces, on striking against the sides of the box, the same sound that would be made by the coin were it inclosed therein. Let us add that this second bottom is covered externally with black cloth glued all around and well stretched over the edge of the four vertical sides of the box.

While the spectators think they hear the coin in the box, the prestidigitator goes to get the second one, which, as we have said, contains a certain number of others that Fig. 3 shows in section. But in advance, all the covers on the one hand and all the boxes on the other have been placed one within another, thus permitting of all of them being closed by a single maneuver after the coin has been placed in the central and smallest box.

As shown in Fig. 4, the covers are held in place with the middle finger of the right hand. In order that they may fit perfectly upon their respective boxes, the whole is slightly shaken, and, if need be, the side of the external box is struck a few times with the magic wand as if to point it out to the spectators.

The rectangular box is then grasped in such a way that no sound is heard any longer, and is immediately opened to show that it is empty. Then the round boxes are opened one after the other.

The spectators, in view of the short time required for this operation, cannot conceive through what magic process it has been possible to cause the coin (which could not have been changed, since the sign with which it is marked bears witness of that) to pass so rapidly to the center of all these boxes.—*La Nature.*

THE CATASTROPHE AT SCHNEIDEMUHL.

SCHNEIDEMUHL, a city of about 16,000 inhabitants in the Province of Posen, is important as the point where several railroad lines of eastern Germany cross. The name of this place is now on every lip, because of a misfortune caused by a strange freak of the elements. In the spring of 1888 the town was afflicted by a flood; the Küddow overflowed its banks, laying the city waste. The effects of this inundation were scarcely wiped out when the neighborhood was visited by another misfortune, which was caused by an attempt to obtain better drinking water.

At the junction of the Kleine Kirchenstrasse with the Grosse Kirchenstrasse there had been a well for a long time. The water of this well was tested and found to be impure. It was then decided to bore deeper, in the hope of finding better water, and the work was begun in the latter part of last year. When a depth of 177 ft. was reached the water rushed forth with terrible power, carrying masses of sand with it. It was hoped that by continuing the boring a pure spring would be reached, and for the sake of working more quickly the tube was driven by means of a pile driver, but the tube became choked and the water forced its way out around the tube. The force of the water increased more and more. Recognizing the danger, advice of experts was sought, but, unfortunately, many places were left without protection. Vain attempts were made to close the bore; the effects of the washout were already showing themselves. In the neighboring houses an uncomfortable snapping and cracking was heard, and crevices appeared, which grew larger and more threatening, and the water forced its way into the cellars. As the danger increased, experts arrived from all sides. Upon their advice, the attempt was made to build a well of masonry around the hole, but this work was too slow. The well expert Beyer, who had been called from Berlin, said that he wanted to plug the bore and at the same time obtain clear water. After working for many days the water was turned off, but obstacles of all kinds had to be overcome; the well suddenly sunk on June 15, and had to be rebuilt.

In boring, rock was often struck, so that the tubes had to be taken out again and new bores undertaken. However, the Berlin expert succeeded in controlling the water to such an extent that by June 19 he had decreased the flood by half. In the mean time a ditch was being dug for carrying the water to the Küddow. June 21 a consultation was held and the order was given for the permanent closing of the well. Herr Beyer began this difficult task and carried it out successfully. When the tube had been carried 52 ft. above the surface the water still forced its way out, but when the tubes had reached a height of 72 ft. it was found that the pressure of the water had been paralyzed. Apparently the danger has been checked, but that is uncertain, for who can tell whether the angry element may not be continuing its destructive work in another direction?

The cause of this catastrophe is still a mystery, but all kinds of theories have been advanced; some say that formerly there was a great pond on this unhappy spot, which was filled up, and others think that the water came from the Vilm Sea, near Neustettin, which had sunken about a yard. It is estimated that the damage done will cost more than $230,000. In the two streets 20 plots of ground with valuable houses were affected, 86 families, including 327 persons, having been forced to abandon their homes. These were mostly fine new houses, for a great many new buildings had lately been erected in this elegant new part of the city. The Grosse Kirchenstrasse is in a particularly bad condition. There are great fissures in the surface of the ground, the pavement of the street and the sidewalk are broken, and there are yawning cracks in the buildings. Parts of the corner houses have already been removed. The Straubel house was in a worse state than the others, the front of the three stories had fallen away entirely, leaving it all open, so

THE CATASTROPHE AT SCHNEIDEMUHL—A RUINED HOUSE.

THE CATASTROPHE AT SCHNEIDEMUHL—THE WATER RUSHING FROM THE BORE.

that the ruined interior could be plainly seen. The Pioneers, who were at work here from June 23 to June 25, blew up this and other buildings that threatened to fall, but it was afterward decided to remove the rest instead of destroying them by means of explosions.

The city and the state were called on to help those who, through no fault of their own, were forced to abandon their property, and a committee of able men was formed to see that the matter was properly attended to.—*Illustrirte Zeitung.*

DORYANTHES GUILFOYLEI.

THE engraving here given shows a most magnificent species of Doryanthes, which flowered for the first time in cultivation some five or six weeks ago in our garden. The plant was the admiration of thousands of visitors who flocked here from the city and country places to see it. There are now four species of Doryanthes known, namely: D. excelsa, the well-known "spear lily" of New South Wales, D. Palmeri, D. Larkini, and this new one which has just been named D. Guilfoylei by the government botanist of Queensland, Mr.

DORYANTHES GUILFOYLEI IN THE BOTANIC GARDENS, MELBOURNE.

Frederick Manson Bailey, F.L.S. D. excelsa is the only species of the four not found in the northern colony. Doryanthes Palmeri was hitherto considered to be the most gigantic and showy amaryllid discovered in Australia, but it is eclipsed in size and beauty by this later discovery. The leaves and flower spikes are enormous. The leaves are each 9 feet long, over 8 inches wide, and of a brilliant green. From the base of the flower stalk (which is 15½ inches in circumference) to the apex of the inflorescence is 16 feet 2 inches. Of this, 7 feet 8 inches is a compound spike of rich crimson amaryllis-like flowers, each 4 inches in length, and supported by 8 feet 6 inches of stalk. The plant was discovered by a brother of mine in the Upper Burdekin Ranges, North Queensland, and when sending the seeds he remarked that it was by no means plentiful, only one patch of it occurring above a cleft of huge rocks, and a solitary specimen about a mile away, from which he fortunately secured fruit. From the leaves a valuable fiber is obtained. This is of great strength, and with proper appliances could no doubt be converted into cloth, ropes, etc. Our gardens were aglow a week or so ago with the beautiful Eucalyptus ficifolia and numerous specimens of Jacaranda mimosæfolia. We find that there are no less than ten varieties of the former, including deep and light crimson, bright scarlet, orange scarlet, rosy pink of several shades, a pure white, and several others. Masses of these trees are a gorgeous sight against a dark green background.—*William R. Guilfoyle in The Garden.*

THE BREAD-FRUIT TREE.

THE bread-fruit tree, *Artocarpus incisa*, seen in the Dutch East Indies and in many of the islands of the South Seas, grows forty to fifty feet high, the fruit being round or slightly oval in shape, first green, then brown, and turning yellow when fully ripe. It is from five to eight inches in diameter, and tastes insipid when cooked. I could not determine what the taste was like, unless it were grocery store brown paper. In Samoa and Tahiti the tree yields a succession of two or three crops during eight months in the year. "Its fruitfulness is said to exceed even the generous plantain, upon which the natives of the tropics subsist almost solely where the bread fruit is not grown. It dispenses entirely with the labor of the agriculturist, the miller, the baker; there need be no care for seed time or harvest; there is no thrashing, no grinding, no kneading; in fact, the islanders of the South Seas have their bread ready prepared and have only to place it on the coals as they need it," says Ober.

This placing on the coals is a picturesque affair, like a Rhode Island clambake. The fruit is cut up, the core removed, and, hot stones having been placed in a hollow in the earth and covered with leaves, the fruit is laid on top and again covered with leaves and hot stones, on which more bread fruit is laid, then another layer of leaves and stones, and on top of all earth is heaped to a depth of six inches or more. The hot-stone bake lasts about thirty minutes, and the result is a brown piece of natural bread, white, or perhaps yellow, inside, and very nutritious. Some think it more like the plantain than wheat bread. It is almost tasteless when cooked green, but is highly appreciated by experts when allowed to ripen just a little, not to the yellow state, however, when it has a decayed flavor. I found it impossible to like it very much in any state, but it seems to be acquired taste with some whom I have heard praise it. This is the seed-bearing bread fruit which grows throughout Polynesia, but the true bread of the Moluccas, which is propagated only by cuttings—the seeds being entirely aborted by cultivation—is a different plant.

If a Polynesian plants twenty ordinary bread-fruit trees he is independent for life, unless his enemy destroys them. The constant feuds of various tribes in the same group, and on the same island, tend to famine, as they wantonly destroy each other's cocoanut palms, banana groves and bread-fruit trees.

The fiber of the inner bark of the bread fruit makes good cloth, but coarser than the "tapa," made from the paper mulberry tree. The wood is soft and light, of a rich yellow, turning to mahogany in use, just right for the dugout canoe. Then the milky juice obtained by puncturing the bole is used as a gum.

Another use is to spread it about as a bird lime, to catch the feathered songsters of the woods. A preparation is also made for tattooing. Usually the Polynesian's house is bamboo leaves and grass; but sometimes bread fruit uprights and beams are used. In fact, this beautiful and useful tree is one of the choicest gifts of nature to the brown man of the tropic seas. Its deeply lobed, dark green, glossy leaves, twelve to eighteen inches long, and its useful, if not luscious fruit, afford him shade and food, and if he does not like baked bread he puts quantities of it in a hole in the ground, often twenty feet in diameter, changing it from sweet to sour, which state it will keep for months. Some of these silos hold a couple of tons.

The indigenous trees of the West Indies and South America, which are of the Artocarpaceæ family, allied to the bread fruit, are the bread nut of Jamaica and the milk or cow tree of Demerara. St. Vincent was the first island of the West Indies where the bread fruit was planted, and there it has flourished to a greater extent than in any other of the Caribbean chain, even invading the forest edges to find a companion in the trumpet tree, which looks like it. It grows on plantations, in groves and in the deeper valleys in a wild state.—*The American Agriculturist.*

THE PLANT EFFECTS IN THE HORTICULTURAL BUILDING.

THE great Horticultural building comprises a dome area from which extend, in each direction, two parallel curtains or wings, which connect the dome with two end pavilions. Between the curtains, on either side of the dome, is a court, one of which is devoted to the California orange orchard and the other to the German wine building and lily tanks. The dome and the two front wings or curtains are devoted to ornamental plants, while the rear wings are devoted to fruit displays. The dome is 187 feet in diameter, and has an inside altitude of 113 feet, while each of the curtains is 270 × 69 feet in floor area. The sides and roofs of these curtains are of glass. In fact, these wings are simply gigantic greenhouses of sufficient height to accommodate tall palms and bamboos. The floor is covered with cinders. This proves to be a very poor material for the purpose, being dirty and unpleasant to walk upon; its dull color is also objectionable among plants. In these great greenhouses many thousand plants are arranged in various fashions, a great number are in pots and some are bedded out.

There are sixteen distinct exhibits by different firms and individuals, but many of the displays are collective. The circular space in the center is occupied by the artificial mound under the dome, and the beds about it are level floor groups of palms and other bold plants.

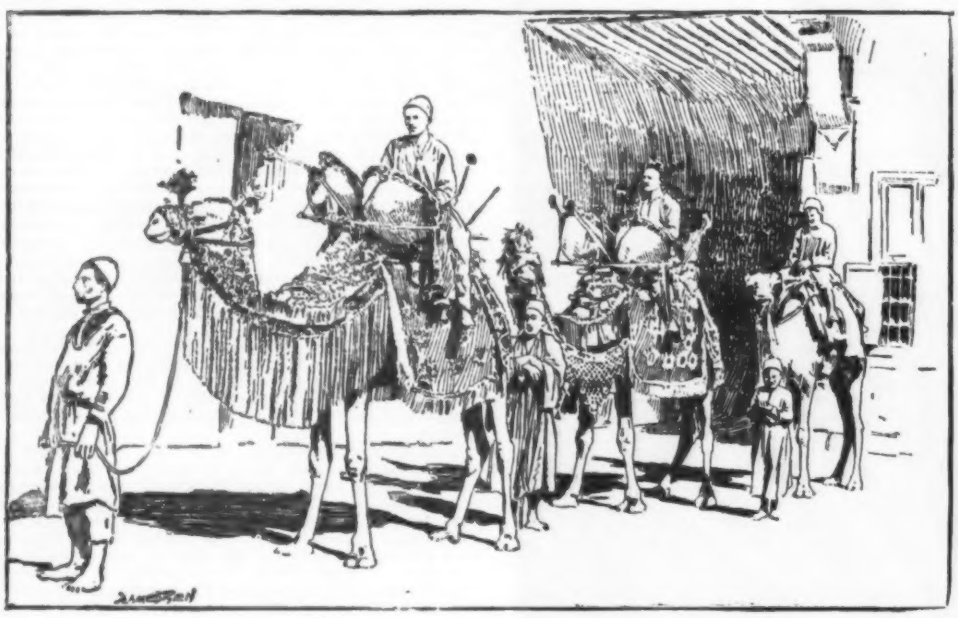
The most conspicuous feature of the interior of the building is this mound, and the effect of the plants massed upon its flanks and summit at once arrests attention. The framework of the elevation, which was designed to represent a mountain, is a rough board scaffolding, beneath which is a crystal cave belonging to a private person, and to this an admission fee is charged. The cave itself is sufficiently out of place in a horticultural building, and the exterior of it, painted red, is but scantily covered by the unhappy plants which are perched upon it. The elevation in no way suggests a mountain and cannot fail to leave an unpleasant impression upon the mind of the visitor. There has been some attempt to construct rocks at intervals on this structure, of painted canvas and other material, but the observer is never deceived as to their character. This pile rises to the height of seventy feet, and the different steps and platforms are occupied by a heterogeneous mixture of plants, among which are boxes of cannas, a good variety of palms, and a crown of ficuses. In order to cover the bare walls, evergreens were cut and adjusted to the vacant spaces, and some of these dead and brown are still in place in mid summer. The structure is full of ugly gaps, many of the plants are dry and sere, and the whole object is a most unhappy and crestfallen spectacle. But, wholly aside from the poor condition of the decoration, its design is without purpose and is bad; it accomplishes nothing more than a rude filling of the space; it represents no mountain vegetation, nor the flora of any land, nor has it any artistic value. The base of this structure is greatly relieved by excellent collections of palms, but these are beginning to look yellow and sickly, probably from the too intense light of the unscreened glass and the great height of the roof.

The group on the north of the dome is contributed by New York, in which exhibitors are the Jay Gould estate, Julius Roehrs and Prospect Park. The collection is under the charge of James Dean, of Bay Ridge. Perhaps the most conspicuous plants in the group, which contains many fine specimens, are Ravenala Madagascariensis or traveler's tree, Seaforthia elegans, Pandanus utilis, Areca lutescens and Arenga Bonnettii, from the estate of Jay Gould; Dracæna Knerkiana, from Mrs. E. Beck, and good specimens of Thrinax elegans, Corypha australis, Pritchardia macrocarpa, Phœnix Canariensis and P. spinosa; also an abundance of sweet bay. As these plants occupy the north side of the dome, they have been spared the ill effects of the unscreened glass, and are mostly in good condition. Pitcher & Manda's collection of palms on the west side is excellent in itself, and comprises some rare and costly species, but it has suffered considerably. Palms in this group worthy of special mention are a Kentia Forsteriana, twenty-five feet high, and carrying sixteen good leaves; Pritchardia Pacifica, and a variegated Latania Borbonica. About 150 varieties of palms were originally placed in this collection. The remaining portion of the dome circle is occupied by Pennsylvania

with various palms of merit, many of which lack good labels.

The south wing contains many plants and groups of great merit, and most of the arrangement is good. Pennsylvania shows a long border, which begins with an admirable collection of variegated caladiums opposite the dome, from George W. Childs, continues through a variety of plants contributed by Robert Craig, Henry A. Dreer and others, and ends on the south with a large collection of ferns from Mr. Dreer. The Pennsylvania displays are in charge of Robert Craig, and they are in good condition throughout. The most decorative or pictorial group in the building is a collection of stove plants in the center of the curtain, from Pitcher & Manda. This group, containing 260 specimens, includes dieffenbachias, alocasias, marantas and begonias, and it has a good setting against the succeeding bed of tree ferns and other large ferns. A short colonnade of tree ferns, the tallest twenty-seven feet in height, comprises the center of the group, with something over one hundred varieties making up the details. Opposite the low group of stove plants is a general collection of orchids, anthuriums, nepenthes and other plants of this class, from Pitcher & Manda. The orchid display of this firm is the only one of importance in the building, and includes forty-seven kinds of Cypripediums, 403 plants of Cattleya Mossiæ, 390 of Cattleya citrina and thirty-four of the new Cattleya gravesiana. Something over a thousand plants of orchids have been shown in this collection.

Following Pitcher & Manda on the south is the most extensive and best collection of begonias with decorative foliage, shown by E. G. Hill & Co. A large collection of cacti is shown beyond this by Mrs. Anna B. Nickels, of Laredo, Texas. The extremity of the curtain is occupied by a general collection of palms, stove plants, gardenias and others, shown by Massachusetts, Missouri, J. C. Vaughan, Albert Fuchs, Chicago, and Texas or Galveston. Opposite the dome, on the west, is a large collection of cycads from Pitcher & Manda, including about thirty varieties. The south curtain presents a certain continuity and progression of effect



THE WORLD'S COLUMBIAN EXPOSITION—WEDDING PROCESSION IN THE STREETS OF CAIRO, MIDWAY PLAISANCE.

which is pleasing, especially when seen from the gallery of the dome. It rises gradually from the low group of stove plants in the foreground to the taller ferns and palms in the rear, and the bright-colored foliage and flowers give it an air of finish which is charming.

The north curtain is much more heterogeneous in its effects. It contains, however, a wonderful collection of plants, especially in the great tree ferns and giant stag-horn ferns from New South Wales, which extend, like a forest, down the middle of the building, and the curious dwarfed trees of the Japanese garden. The foreground of this curtain is flanked by a tasteful group of palms and other tropical plants sent by Ontario and under the charge of Mr. Gilchrist. At the extreme end Trinidad interposes a bold group of palms and bamboos. Roses and azaleas are shown on the west side by Germany and Belgium; and Mexico balances Ontario with a very remarkable collection of cacti. As seen from the north gallery of the dome, this wing produces a most gaudy and bewildering effect, because of the individuality of the groups and the profuse use of banners and pendants by the New South Wales exhibit. The Japanese garden is the unique feature in the curtains and is worth a detailed description.

Although there are some details in these plant curtains which seem to jar with the spirit of the design—especially the booths and sales stands—the general effect is good, especially when it is considered how hastily the collections were procured and the many difficulties which are met with in carrying out so great an enterprise. It is to be regretted that there are not more individual growers and firms concerned in the exhibits, and that the educational features have often been overshadowed by attempts at mere decoration. The dome piece is the feature open to most serious criticism, and this is altogether bad. It is but just to say that the dome is too immense to allow of wholly satisfactory treatment at a temporary exhibition, and the fault lies in trying to fill it. The side curtains, on the other hand, are of such shape that they give a long perspective and readily lend themselves to good effects. —*L. H. Bailey, Garden and Forest.*

THE COLUMBIAN EXPOSITION—DEPARTMENT OF FINE ARTS AWARDS.

THE official list of awards in the Department of Fine Arts, as given out by the National Committee on Awards, is as follows: To each of the artists a medal and a diploma setting forth the points of excellence in his works were awarded. The exhibition of paintings made by French artists was disappointing to the jurors. An average of 10 per cent. of the 9,000 pictures in the Art Palace received awards. The following is the list, classified by nations:

UNITED STATES.

Oil Paintings.—J. S. Sargent, C. C. Curran, C. H. Davis, Mark Fisher, Henry Bishing, George De Forest Brush, H. S. Mowbray, Irving R. Wiles, Frank W. Benson, Henry O. Walker, J. Francis Murphy, C. H. Turner, George Hitchcock, Winslow Homer, E. Tarbell, Eastman Johnson, C. Morgan McIlheney, Robert Reed, A. H. Thayer, C. A. Platt, Elihu Vedder, Jalden Wyers, G. R. Donoho, Robert Vonnoh, E. E. Simmons, Theodore Robinson, Thomas Eakins, Childe Hassam, F. P. Vinton, F. W. Freer, Walton Palmer, George Inness, T. W. Dewing, Alfred Kappes, Gilbert Gaul, S. F. Urich, Bolton Jones, Horatio Walker, L. C. Tiffany, J. McNeill Whistler, Douglas Volk, D. W. Tryon, Fred S. Church, William L. Picknell, Orin Peck, D. Ridgway Knight, William H. Howe, Louis P. Dessar, Edwin A. Abbey, Edwin H. Blashfield, Leonard Ochtman, Kenyon Cox, Thomas S. Clark, W. S. Kendall.

Water Colors.—Ben Foster, W. T. Smedley, F. Doveneck, J. H. Twatchman, Mary F. MacMonnies, Childe Hassam, Sarah T. Sears, P. F. Zogbaum, C. Morgan McIlheney, C. D. Gibson, Emma E. Lampert, Harry Fenn, Clara F. McChesney, Joseph Pennell, Rhoda Homes Nichols, W. S. Metcalf, August Franzen, Miss Elizabeth Nourse, Louis C. Tiffany, Miss Caroline A. Lord.

Pastels.—Julius Rolshoven, J. Appleton Brown, R. Emmet Sherwood, Henry Murhman, Burge Harrison.

Black and White.—Gilbert Gaul, A. B. Wenzell, Frederick Remington, W. I. Smedley, A. B. Frost, Carleton T. Chapman, Thule de Thulstrup, W. Hamilton Gibson, Edwin A. Abbey, Howard Pyle, Will H. Low, C. Redwood, A. Castaigne, C. S. Reinhart, Robert Blum.

GREAT BRITAIN.

Oil Paintings.—J. M. Swan, J. C. Hook, George Clausen, W. W. Ouless, W. Q. Orchardson, Mrs. Adrian Stokes, Henry Woods, William Carter, Peter Oraham, J. W. Waterhouse, James Sant, William Logsdail, A. C. Gow, Mrs. Stanhope Forbes, H. Fisher, Ernest Parton, A. Stokes, Mrs. Clara Montalba, J. E. Millais, G. Weatherbee, Frank Brangwyn, G. H. Boughton, Henry S. Tuke, T. C. Gotch, Alma Tadema, Seymour Lucas, David Murray, Mrs. Annie L. Swinnerton, Arthur Hacker, W. L. Wyllie, E. A. Waterlee, Robert M. Macbeth, Marcus Stone, John R. Reed, Yeend King, L. H. La Thangue, Alfred Parsons, Miss Anna Alma Tadema, Walter Osborne, James Childs, W. H. Bartlett, Mrs. Alma Tadema, Frank Dicksee, A. C. Taylor, Henry Moore, Edward Stott, Hubert Herkomer, Albert Moore, Sir Frederick Leighton, Briton Riviere, Mrs. Anna La Merret, Mary E. Stewart Wood, John Lavoy, S. J. Solomon, Walter Langley, Colin Hunter, Mouat Loudan, John Gilbert, Frank Bramley, Andrew C. Gow, Charles W. Wyllie, James D. Linton, Lady Butler. Tom Lloyd, William Stott, Edwin Hayes, E. A. Walton, J. J. Shannon, Henry Moore, Morley Fletcher, Birket Foster, T. R. Morris, Henry George Hine, Alfred East, W. L. Wyllie, William Titcomb, Lionell P. Smythe, D. W. Leader, Leopold Rivers. Frederick Brown, Mrs. Allingham, A. Stanhope Forbes, Henrietta Rae, J. W. Joy, S. Milton Fisher.

Black and White.—T. F. Goodall, J. R. Weguelin, Leslie Thompson, George du Maurier, John Tenniel.

Water Colors.—John C. Harlton, J. Hay Henshall, W. H. Overend. W. Rainey, John M. Swan, A. East, James D. Linton, W. Hatherell, Kate Greenway, H. Coutts, F. S. Seymour Hayden, Alfred Parson.

GERMANY.

Oil Paintings.—Peter Jansen, Franz Carbina, Anton Braith, Christ Kroner, Herman Kaulbach, Heinrich Hermanns, Mrs. Vilma Parlaghy, Carl N. Bantzer, Joseph Block, Henri Heimes, Oscar Frenzel, F. Stahl, Walther Leistekow, Keller Reutlingen, Eugene Ducker, Alfred Zoff, Furd Max Brodt, Victor Weishaupt, Franz Roubadt, Max Liebermann, Paul Hoecker, Fritz von Uhde, Otto Friederich, Theodore Hummel, F. von Schennis, Hans Hermann, E. Schwabe, Wilhelm Volz, Ferd Kesler, Gelth Kuhl, Franz von Lenbach, Heinrich Zugel, Ernst Zimmerman, E. Bracht, Ludwig Kraus, Herman Baisch, Carl Saltzmann, J. von Brandt, Max Koner, Oswald Achenbach, Wil H. Truebener, H. Liesegang, A. Menzel, Karl Hartmann, Ferdinand Brutt, Richard Scholtz, Paul Meyer Mainz, Carl von Stetten, Franz von Deffregger, M. Thedy, H. Konig, J. Falat, Gabriel Max, Max Pietschman, Benjamin Vaulter, Andersen Lundby, E. Hausmann, Carlos Grothe, P. P. Muller, Gust Schonleber, Paul Meyerheim, Miss Fanny Edle von Geiger, Ernst Oppler, C. L. Bockmann, Ludwig Herterich, Franz Simm, Mrs. Begas-Parmentier, Mrs. Marie Kalkrouth, Mrs. August E. Shepps, and Miss Agnes Stamer.

Black and White.—Adolph Menzel, F. Stuck, A. Oberlander.

Water Colors.—Adolph Menzel, R. Reinecke, Franz Skarbins, Hans von Bartels, Hans Herman, —— Dettman, M. Seliger, Eugene Klinsch.

Large Oil Painting on Porcelain.—A. R. Kipps.

AUSTRIA.

Oil Paintings.—A. Ditscheimer, Lina Roeher, Tina Blau, K. Moll, Rudolph Ribarz, B. Kunpfer, Vacslav Brozik, Eugen Jettoll, F. von Defergger, Hans Temple, Julius von Puasinger, Frantz Simm, Heinrich von Angeli, Adel Selinmann, Carl Zewey, A. Zetsche, Olga Wiesinger, Mrs. Marie Mueller, Mrs. F. von Kirschberg.

HOLLAND.

Oil Paintings.—M. Ander Maarel, N. Bastert, William Maris, T. Offermans, P. I. C. Gabriel, Georga Poggenbeck, W. B. Tholen, Miss Theresa Schwartz, H. J. Melis, Jacob Maris, Jan Vrolyk, B. J. Blommers, Albert Neuhuhs, Theophile de Bock, Mrs. M. Roosenboom, J. H. L. de Haas, J. S. H. Kever.

Water Colors.—J. S. H. Keever, Jacob Maris, M. Ander Maarel, William Maris, Albert Neuhuhs, Mrs. H. Grandmont Donders, Josselin de Jong, J. H. Weissenbruck.

ITALY.

Oil Paintings.—E. Careano, M. G. Zanetti, G. Beldini, M. Corteggiani, E. Prati, S. Corelli, Dall Oca Bianca, G. Bottero, P. Traigiacome, S. Novo, R. Santore, Da Molina, G. Ciardi, L. Rossi, T. Lessi.

SOCIETY OF POLISH ARTISTS.

Oil Paintings.—W. Prusskowski, John Mateyke, S. Kadzerski, J. Ryszkiewicz, W. Gersen, W. Telmayer, Z. Jasinski, W. Pieckowski.

CANADA.

Oil Paintings.—J. A. Frazer, G. A. Reed, T. C. V. Ede, Sarah B. Holden, Robert Harris.

JAPAN.

Oil Paintings.—Kawabata Gyiokusho, Iamo Keinen, Mochizuki Gyekusen, Tasaki Zowun, Neguchi Yukoku, Taniguchi Taichi, Hara Ryntaro, Munemura Keizan, Ujii Sezan. Mori Shunaku, Asae Rynkio, Takeuchi Seihe, Kubota Beisen, Taniguchio Koke.

Painting on Enamel.—Namikawa Sosuke, Kumagain Naohoiko, Hashimoto Gaho, Kawada Shibasaro, Suzuki Shonen, Koz Shoseki, Hasegawa Gyokujun, Ogata Gekko.

Painting on Lacquer.—Morimura Ichitaro, Taki Katei, Ikeda Taishin, Asano Sozaburo, Kawanobe Itcho, Igarashi Tajiro, Morichita Moriachai.

Painting on Porcelain.—Miyagawa Koxan, Takemote Havato.

SPAIN.

Oil Paintings.—J. Garnelo, Felix R. Hidalgo, Santiago B. Rusinol, Jose F. Tapire, Antonio Degrain, De Baruele, Juan Planella Y. Rodriguez, Dumond Alvarez, Aranda Gimenez, Fernandez E. Pelaye, Carbonero Moreno, Gonzalo S. Bilbao, C. M. Ramirez, Luis Alverez, Joaquin Soroella, Enrique Simonet, Aranda Gimines, Sedano Santa Maria, M. Dominguez, Jose Gartner, Juan Loubre, Roselle, R. Luna, J. L. Garcia Pilliser, Maria Poiala, C. Santa.

Pastel.—Jose de Pado.

Water Color.—J. Tangiers Tapiro.

Black and White.—J. Rios.

VENEZUELA.

Oil Paintings.—A. Herra Toro, Artino Michelema, Christobal Rojas.

SWEDEN.

Oil Paintings.—Nils Kruger, Carl Tradgardh, Alf Wallander, Brune Litjefers, Ida von Schulzenheim, Earl H. Nordstrom, A. Schultzberg, O. Bjork, A. Jungstedt, O. Arboreliu, Carl Larssen, Prince Eugene.

Water Colors.—Carl Larssen and Carl Kjellin.

Pastel.—Prince Eugene.

Black and White.—Bruno Litjefers.

DENMARK.

Oil Paintings.—Lauritz Tuxen, Johan C. Schiltkrull, V. Irminger, P. S. Kroyen, Vigo Johansen, F. R. Wither, L. Paulsen, W. V. Dorph, N. P. Mols, P. Hansen, H. I. Brandekilde, A. Olsen.

MEXICO.

Oil Paintings.—Jose Maria Velasco, Gertrudi Schmitein.

NEW SOUTH WALES.

Oil Paintings.—W. Lister, Thomas Roberts, A. H. Fullwood, Mrs. Ellis Rowan.

ARGENTINE REPUBLIC.

Oil Paintings.—Della Kalle, N. Orlandi.

BRAZIL.

Oil Paintings.—J. F. Almeida, Jr., Elisen d'Angelo Visconti, Pedro Weingartner, M. Brocos, Henrique Bernadello.

Water Colors.—Henrique Bernadello.

Pastels.—Henrique Bernadello, Rudolpho Amoedo.

[Continued from SUPPLEMENT, No. 921, page 14726.]

THE END OF OUR WORLD.

By CAMILLE FLAMMARION.

EVEN if the sun be actually in a gaseous state, its temperature, so far from growing less or even remaining stationary, would increase by the very fact of contraction, for if, on the one hand, the temperature of a gaseous body falls when it condenses, on the other hand, the heat generated by contraction is more than sufficient to prevent a fall in temperature, and the amount of heat increases until a liquid state is reached. The sun seems to have reached this stage.

The condensation of the sun, whose density is only one-fourth that of the earth, may thus of itself maintain for centuries—at least for ten million years—the light and heat of this brilliant star. But we have just spoken of a second source of heat—the fall of meteorites. One hundred and forty-six million meteorites fall upon the earth yearly. A vastly greater number fall into the sun, because of its greater attraction. If their mass equals about the one hundredth part of the mass of the earth, their fall would suffice to maintain the temperature—not by their combustion, for if the sun itself was being consumed, it would not have lasted more than six thousand years, but by the sudden transformation of the energy of motion into heat, the velocity of impact being 650,000 meters per second, so great is the solar attraction.

If the earth should fall into the sun, it would make good for 95 years the actual loss of solar energy. Venus would make good this loss for 84 years, Mercury for 7, Mars for 13, Jupiter for 32,254, Saturn for 9,652, Uranus for 1,610 and Neptune for 1,890 years. That is to say, the fall of all the planets into the sun would produce heat enough to maintain the present rate of expenditure for about 46,000 years.

It is therefore certain that the fall of meteors greatly lengthens the life of the sun. One thirty-third millionth of the solar mass added each year would compensate for the loss, and half of this would be sufficient if we admit that condensation shares equally with the fall of meteorites in the maintenance of solar heat; centuries would have to pass before any acceleration of the planets' velocities would be apparent.

Owing to these two causes alone we may therefore admit a future for the sun of at least twenty million years, and this period cannot but be increased by other unknown causes, to say nothing of an encounter with a swarm of meteorites.

The sun, therefore, was the last living member of the system; the last animated by the warmth of life.

But the sun also went out. After having so long poured upon his celestial children his vivifying beams the black spots upon his surface increased in number and in extent, his brilliant photosphere grew dull, and his hitherto dazzling surface became congealed. An enormous red ball took the place of the dazzling center of the vanished worlds.

For a long time this enormous star maintained a high surface temperature and a sort of phosphorescent atmosphere; its virgin soil, illumined by the light of the stars and by the electric influences which formed a kind of atmosphere, gave birth to a marvelous flora, to an unknown fauna, to beings differing absolutely in organization from those who had succeeded each other upon the worlds of its system.

But for the sun also the end came, and the hour sounded on the timepiece of destiny when the whole solar system was stricken from the book of life. And one after another the stars, each one of which is a sun, a solar system, shared the same fate, yet the universe continued to exist as it does to-day.

The science of mathematics tells us: "The solar system does not appear to possess at present more than the one four hundred and fifty-fourth part of the transformable energy which it had in the nebulous state. Although this remainder constitutes a fund whose magnitude confounds our imagination, it will also some day be exhausted. Later, the transformation will be complete for the entire universe, resulting in a general equilibrium of temperature and pressure.

"Energy will not then be susceptible of transformation. This does not mean annihilation, a word without meaning, nor does it mean the absence of motion, properly speaking, since the same sum of energy will always exist in the form of atomic motion, but the absence of all sensible motion, of all differentiation, the absolute uniformity of conditions, that is to say, absolute death."

Such is the present statement of the science of mathematics. Experiment and observation prove that on the one hand the quantity of the matter, and on the other hand the quantity of energy also, remains constant, whatever the change in form or in position; but they also show that the universe tends to a state of equilibrium, a condition in which its heat will be uniformly distributed. The heat of the sun and of all the stars seems to be due to the transformation of their initial energy of motion, to molecular impacts; the heat thus generated is being constantly radiated into space, and this radiation will go on until every sun is cooled down to the temperature of space itself. If we admit that the sciences of to-day—mechanics, physics, and mathematics—are trustworthy, and that the laws which now control the operations of nature and of reason are permanent, this must be the fate of the universe.

Far from being eternal, the earth on which we live has had a beginning. In eternity a hundred million years, a thousand million years or centuries are as a day. There is an eternity behind us and before us and all apparent duration is but a point. A scientific investigation of nature and acquaintance with its laws raises, therefore, the question already raised by the theologians, whether Plato, Zoroaster, St. Augustine, St. Thomas Aquinas, or some other young seminarist who has just taken orders: "What was God doing before the creation of the universe, and what will he do after its end?" Or under a less anthropomorphic form, since God is unknowable: "What was the condition of the universe prior to the present order of things, and what will it be after this order has passed away?"

Note that the question is the same, whether we admit a personal God, reasoning and acting toward a definite end, or whether we deny the existence of any spiritual being and admit only the existence of indestructible atoms and forces representing an invariable sum of energy. In the first case, why should God, an eternal and uncreated power, remain inactive? Or, having remained inactive, satisfied with the absolute infinity of his nature, which nothing could augment, why did he change this state and create matter and force? The theologian may reply, "Because it was his good pleasure." But philosophy is not satisfied with this change in the divine purpose. In the second case, since the origin of the present condition of things only dates back a certain time, and since there can be no effect without a cause, we have the right to ask what was the condition of things anterior to the formation of the present universe.

Although energy is indestructible, we certainly cannot deny the tendency toward its universal dissipation, and this must lead to absolute repose and death, for the conclusions of mathematics are irresistible.

Nevertheless, we do not concede this.

Why?

Because the universe is not a definite quantity. It is impossible to conceive of a limit to the extension of matter. Limitless space, the inexhaustible source of the transformation of potential energy into visible motion and thence into heat and other forces, confronts us, and not a simple finished piece of mechanism, running like a clock and stopping forever.

These measures are relative and arbitrary, but time itself exists, like space, independently of them. Suppress everything, space and time would still remain; that is to say, space which material things may occupy and the possibility of the succession of events. If this were not so, neither space nor time would be really measurable, not even in thought, since thought would not exist. But it is impossible for the mind even to suppress either the one or the other. Strictly speaking it is neither space nor time that we are speaking of, but infinity and eternity, relative to which every measure, however great, is but a point.

We do not comprehend or conceive of infinite space or time, because we are incapable of it. But this incapacity does not invalidate the existence of the absolute. In confessing that we do not comprehend infinity we feel it about us, and that space, as bounded by a wall or any barrier whatever, is in itself an absurd idea. And we are equally incapable of denying the possibility of the existence, at some instant of time, of a system of worlds whose motions would measure time without creating it. Do your clocks create time? No; they do but measure it. In the presence of the absolute our measures of both time and space vanish, but the absolute remains.

We live then in the infinite, without doubting it for an instant. The hand which holds this pen is composed of eternal and indestructible elements, and the atoms which constitute it existed in the solar nebula whence our planet came, and will exist forever. Your lungs breathe, your brains think, with matter and force which acted millions of years ago and will act endlessly. And the little globule which we inhabit floats, not at the center of a limited universe, but in the depth of infinity, as truly as does the most distant star which the telescope can discover.

The best definition of the universe ever given, to which there was nothing to add, is Pascal's:

"A sphere whose center is everywhere and circumference nowhere."

It is this infinity which assures the eternity of the universe.

Stars, systems, myriads, milliards, universes succeed each other without end in every direction. We do not live near a center which does not exist, and the earth, like the furthest star, lies in the fathomless infinite.

No bounds to space. Fly in thought in any direction with any velocity for months, years, centuries, forever, we shall meet with no limit, approach no boundary; we shall always remain in the vestibule of the infinite before us.

No bounds to time. Live in imagination through future ages, add centuries to centuries, epoch to epoch, we shall never attain the end; we shall always remain in the vestibule of the eternity which opens before us.

In our little sphere of terrestrial observation we see that through all the transformation of matter and motion the same quantity of each remains, though under new forms. Living beings afford a perpetual illustration of this—they are born, they grow by appropriating substances from the world without, and when they die they break up and restore to nature the elements of which they are composed. But by a law whose action never ceases other bodies are constituted from these same elements. Every star may be likened to an organized being, even as regards its internal heat. A body is alive so long as respiration and the circulation of the blood makes it possible for the various organs to perform their functions. When equilibrium and repose are reached death follows; but after death all the substances of which the body was formed are wrought into other beings. Dissolution is the prelude to recreation.

Analogy leads us to believe that the same is true of the cosmos. Nothing can be destroyed. There is an incommensurable Power, which we are obliged to recognize as limitless in space and without beginning or end in time, and this Power is that which persists through all the changes in those sensible appearances under which the universe presents itself to us.

For this reason there will always be suns and worlds, not like ours, but still suns and worlds succeeding each other through all eternity.

And for us this visible universe can only be the changing appearance of the absolute and eternal reality.

It is in virtue of this transcendent law that long after the death of the earth, of the giant planets and the central luminary, while our old and darkened sun was still speeding through boundless space, with its dead worlds on which terrestrial and planetary life had once engaged in the futile struggle for daily existence, another extinct sun, issuing from the depths of infinity, collided obliquely with it and brought it to rest!

Then in the vast night of space, from the shock of these two mighty bodies was suddenly kindled a stupendous conflagration, and an immense gaseous nebula was formed, which trembled for an instant like a flaring flame, and then sped on into regions unknown. Its temperature was several million degrees. All which here below had been earth, water, air, minerals, plants, atoms, all which had constituted man, his flesh, his palpitating heart, his flashing eye, his armed hand, his thinking brain, his entrancing beauty, the victor and the vanquished, the executioner and his victim, and those inferior souls still wearing the fetters of matter—all were changed into fire. And so with the worlds of Mars, Venus, Jupiter, Saturn and the rest.

It was the resurrection of visible nature. But those superior souls which had acquired immortality continued to live forever in the hierarchy of the invisible psychic universe. The conscious existence of mankind had attained an ideal state. Mankind had passed by transmigration through the worlds to a new life with God, and freed from the burdens of matter, soared with an endless progress in eternal light.

The immense gaseous nebula, which absorbed all former worlds, thus transformed into vapor, began to turn upon itself. And in the zones of condensation of this primordial star mist, new worlds were born, as heretofore the earth was.

So another universe began, whose genesis some future Moses and Laplace would tell, a new creation, extraterrestrial, superhuman, inexhaustible, resembling neither the earth, nor Mars, nor Saturn, nor the sun.

And new humanities arose, new civilizations, new vanities, another Babylon, another Thebes, another Athens, another Rome, another Paris, new palaces, temples, glories, and loves. And all these things possessed nothing of the earth, whose very memory had passed away like a shadow.

And these universities passed away in their turn. But infinite space remained, peopled with worlds and stars, and souls, and suns, and time went on forever.

For there can be neither end nor beginning.

THE SPECTROSCOPE AT THE LICK OBSERVATORY.

THE San Francisco *Chronicle* says that the corps of astronomers at the observatory on Mount Hamilton are now completing the results of Prof. Schaeberle's observation of the great eclipse of the sun observed in Peru; watching that recent wonderful heavenly visitant, the comet; studying the "bright line" stars, and other matters incidental to the work of this the greatest observatory of the world.

It has never been definitely known of what comets were composed, but Prof. Campbell has been observing the recent additions to the firmament at all favorable opportunities with the big telescope and its spectrum attachment. The result of his observation has been that the spectrum lines show that the comet is composed of incandescent carbon and nitrogen, being itself luminous. This has been the theory heretofore, but it had never before been actually determined. The spectrum revealed the hitherto suspected truth. While the astronomers are satisfied with the observations of this comet, yet much is still in doubt, and will not be solved until some big comet appears, such as has presented itself in past years before the present means of observation were known. If such a comet should heave in sight, all other work would be suspended, and all eyes turned upon it, resulting undoubtedly in astonishing and almost unhoped-for results.

Prof. Campbell at present is devoting most of his time and attention to the study of the "bright line" stars, training the great lens upon them night after night. His work is greatly aided by the spectroscope. Of these stars there are only thirty-two in this hemisphere capable of being observed, the remainder, about nineteen in number, being in the southern hemisphere, and not visible at the Lick. When the spectrum is placed on the telescope, and the lens trained upon one of these stars, the light from the star is broken up and analyzed by the spectrum, and the colors obtained arranged in a broad band, according to their intensity. Intersecting this band are bright lines, whence these stars receive their name. The lines, according to their position among the colors, denote a preponderating abundance of some element, one position indicating hydrogen, another tin, another iron, and so through the list of elements. In some of these stars the number of bright lines is much greater than in others, and this shows that the stars are in different stages of development.

From these observations Prof. Campbell hopes to perfect a definite theory in regard to sidereal evolution, which will show whether the star is a new one or one partly burned out or one entirely dead. All observations hitherto have been made with comparatively small telescopes, and but few lines were brought out in any of the spectra, but when the thirty-six inch lens, with its wonderful power, was turned upon them many new bright lines were brought out, revealing the fact that the state of the stars was far different from what was supposed. Continued observations will be made upon these stars, and many new and interesting facts may soon be discovered.

A very interesting object of observation has been the new star in the constellation of Auriga, called Nova Auriga, discovered on February 1, 1892, by Prof. Andrews, of the Edinburgh Observatory. When first discovered the star was of the fifth magnitude and was visible to the naked eye. It remained in this state for six weeks. It then decreased in intensity and was visible only in the large telescope for a period of six weeks more, when it totally disappeared. In August of last year it again appeared, having increased to the tenth magnitude, and it has remained in sight ever since, increasing in brilliancy and commanding great attention in all the observatories of the world. It is now supposed to be in the first stage of sidereal evolution. In the past twenty centuries only twenty of these new stars have been discovered, and the extreme rareness of their appearance adds greatly to the interest in them.

The most important question in regard to Nova Auriga was the nature of it. Here and at Pultowa, Russia, where the second largest telescope in the world is located, the lens being thirty inches in diameter, the observation tended to show that it was a planetary nebula or a nebulous star, but this theory has been denied by leading English and German astronomers, who have claimed that it was a true star. Recent observations at Mount Hamilton disprove the theory of its being a true star, and establish the fact that it is a nebulous body. The spectrum exhibited exactly the

same features as the spectrum of those stars which are admitted to be nebulæ.

Without doubt the spectrum has proved to be the most valuable scientific aid to astronomers of all discovered in recent years. While it has been in use for nearly twenty years, yet it has been only in the last five years that it has proved to be of much value. It is now used both visually and photographically. The Lick Observatory will soon be furnished with a new spectroscope of the latest and best manufacture, D. O. Mills having given a sum of money sufficient to purchase such a one as is needed.

THE GENESIS OF PETROLEUM AND ASPHALT IN CALIFORNIA.

By A. S. Cooper, C.E.

There are certain shales which hold in a state of intimate admixture a variable proportion of comminuted matter approaching to coal in its chemical nature. These shales yield by destructive distillation volatile hydrocarbons resembling those obtained from asphalt and petroleum. Analogous products are obtained by the distillation of lignite, peat, wood, coal and animal remains. Their infusibility and insolubility in liquids like benzole and bisulphide of carbon serve to distinguish these carbonaceous shales and substances from the solid bitumens. These shales exist throughout the world in enormous quantities. This organic matter was deposited with the sediment in ancient sea bottoms, just as vast quantities of organic matter are being deposited to-day in the mud at the bottom of our existing seas. In the sea of Sargasso vast quantities of seaweeds of gigantic size are continually sinking to the bottom and becoming incased in mud—vegetation brought down by rivers and covered with silt.

In ancient times these sources of supply were vastly greater than at present, the growth of plant life being much more luxuriant. These muds and silts have by time become indurated into shale or other rocks.

DISTILLATION.

"The maximum quantity of liquid hydrocarbons is obtained from the solids by a process of distillation, under high pressure and low temperature, combined with rapid condensation. Temperature and pressure exercise a considerable influence on the nature of the products of distillation. The method of cooling also exercises great influence in the rearranging of the molecules and upon the nature of the products of distillation. Slow cooling or quick cooling makes no difference on some substances, but the difference between slow and rapid cooling has a marked effect on other substances.

"If we reduce the heat of water from a high to a low temperature, it will not affect the constitution of the water; whether we lower the temperature slowly or quickly, the result will be the same. Water that is slowly cooled from the boiling point down to the freezing point will have the same properties as water that is rapidly cooled down from 212° to 32°; but that does not hold good with all substances; for example, if we take three bars of steel of equal dimensions and make them all red hot; then, if we slowly cool one bar down to, say, 50° in the air, and if we cool the second bar by slipping it slowly into cold water, and if the third bar be suddenly cooled by plunging it into cold water, the effect of cooling these three bars of steel will produce a different effect in each bar. The bar that is slowly cooled in the air will remain comparatively soft and be of a fibrous texture, malleable and ductile, capable of being bent double without breaking. The second bar will be much harder and more elastic, and can only be bent a small degree without breaking. The third bar will be very hard and brittle and cannot be bent, and if struck with a hammer will fly to pieces, the fracture showing a crystalline structure. Now these three bars were simply deprived of the same number of degrees of heat. They were reduced from an equally high degree of heat to an equally low temperature; but we find that the difference in time occupied in cooling makes a vast difference in the molecular structure and properties of the metal. These facts are well known to all workers in metal, but it is not so well known that in cooling mixed gases, especially the hydrocarbons, from a high to a low temperature, the effect on the constitution of the gases varies with the time occupied in cooling, and that the difference between quiescence and agitation during cooling has different effects on the molecular constitution of mixed gases, especially with mixed hydrocarbons.

"Place two retorts of the kind used for making illuminating gas from coal in one oven, so that they get equally heated up to a bright red heat, and let us charge each retort with one hundredweight of good coal which will make 500 feet of gas. Now let us cool the gas from retort No. 1 slowly, by passing the gas slowly through a number of pipes placed vertically in open air in the manner usually done in gas works, and let us cool the gas from No. 2 retort rapidly, by passing the gas through a multitubular condenser surrounded with a freezing mixture; we shall find the result to be that 500 feet of permanent gas and 5 lb. of tar will be delivered by No. 1 retort, and we shall get about 300 feet of permanent gas and 13 lb. of tar from No. 2 retort. There we find that rapid condensation reduces two-fifths of the gas to the liquid state; and if we were to distill under high pressure and low temperature, we should, with rapid condensation accompanied with agitation, reduce nine-tenths of the gas to a liquid state. To produce permanent gas from coal we should distill under low pressure and high temperature and cool the gas very slowly; but if we wish to produce tar and oil, we should distill under high pressure and low temperature and cool the vapors rapidly under agitation. When gas is violently agitated during the cooling process, a greater quantity is condensed into the liquid state than when kept in a quiescent state during the cooling process."

The boiling points of the hydrocarbons of petroleum are altered very considerably by foreign or even by the traces of foreign substances being present.

The nature of the product also depends on the material of the retort. A rough surface will frequently facilitate chemical changes.

"What is known under the general name of petroleum includes a series of hydrocarbon oils varying widely in physical properties. Some are limpid fluids, with many intermediate grades, others are found viscid and even tar-like.

"Their color, by transmitted light, ranges from a light yellow through orange and red to a reddish brown, so dense as to be translucent only in thin films, while by reflected light it passes from a light, dusky color to a dark green and to a black. They differ as markedly in odor and also in other properties, some having a very disagreeable smell, while that of others is considered even pleasant."

There is a wide range in their gravity. The greater the quantity of carbon in proportion to the hydrogen any one of them contains, the greater is its specific gravity, the highest its boiling point and density of vapor.

In the same oil field, the same series of strata, and in the same stratum there are differences of composition.

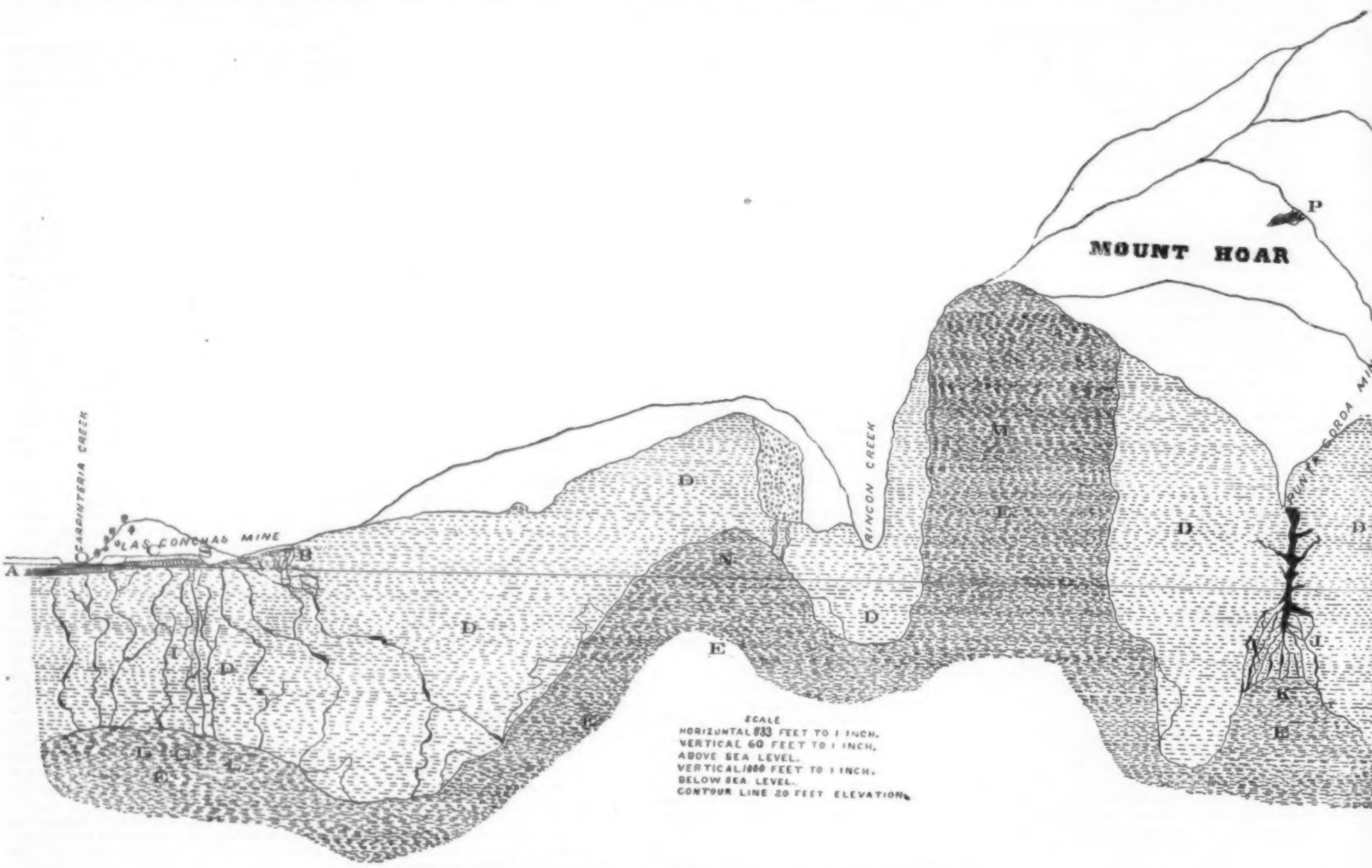
The following are the products of the distillation of crude petroleum: Cymogene, rhigolene, gasolene, naphtha, benzine, kerosene, and maltha. There is no well-marked division line between any of the above-named products, but they gradually merge one into the other. Their division is simply one of caprice. These hydrocarbons are extremely complex and different in composition. The proportion of carbon and hydrogen is extremely variable. There seems to be no end to the different combinations of hydrogen and carbon.

The great diversity in the physical and chemical condition of petroleum can be attributed:

1. To the organic remains from which it is distilled, some being the remains of animals of different kinds, others marine vegetation, others terrenial vegetation. By natural process these organic remains may have been changed into peat or coal, lignite or bituminous, before distillation.
2. The degree of temperature to which these organic remains are subjected during distillation.
3. The pressure to which it is subjected during distillation.
4. The time consumed in effecting distillation.
5. The presence of different substances during distillation—sulphur, lime, water, etc.
6. The condensation of the bitumen after distillation, whether rapid or slow, agitated or quiescent.
7. The material of the still.
8. To its oxygenation when exposed to the atmosphere.
9. To evaporation.

The sectional view and map are of a territory twelve miles east of Santa Barbara, California.

Details and Explanations of Sectional View.—D D, shales holding in a state of intimate admixture carbonaceous matter; E, burnt shale and shale now burning and from which the carbonaceous material is being distilled. At N and M this burnt and burning shale forms part of the bluff on the ocean shore. It is burnt yellow and to a light pink, gradually approaching in color a dark red. Some of it is vitrified. A tunnel excavated at M, near the sea level, showed a temperature of 130° F. when it had entered the bluff a distance of seventy feet. When the atmosphere is in the right condition, vapors are condensed on the top of the bluff by the warmth of the internal fire. In the year 1887 smoke issued from the bluff at N for a period of four months. The bluffs are continually warm on the surface. After the shale has been subjected to this subterranean heat, all carbonaceous matter has disappeared from the shale. It has been eliminated by distillation. These evidences of subterranean heat occur in the vicinity of nearly all of the asphalt and petroleum deposits in the State. At a number of places in Santa Barbara County where natural gas issues the ground for a circumference of thirty feet is devoid of vegetation, and is warm to such an extent that the cattle seek these places to sleep, on account of the warmth afforded. South of Santa Paula, in Ventura County, near the oil district, mountains of this red, pink, yellow and burnt shale exist. On Las Pozitas ranche, near the More and La Patera asphalt



PETROLEUM AND ASPHALT IN CALIFORNIA.

deposits, on the bluff of the ocean, the ground is burnt to such an extent that about one-eighth of an acre has sunk some fifteen feet. These bluffs are still hot, a thin vapor frequently arising from the same. At the King Solomon asphalt mines and the Palos Blancos deposits great quantities of these colored and burnt shales exist. At the Buenavista asphalt mines near Bakersfield, Kern County, nature, after laboring for a great number of years in distilling bitumen from the shales by subterranean heat, destroyed nearly all of the accumulated bitumen when the fires reached the surface. The ground shale and asphalt has been burnt for nearly a mile in length by one quarter of a mile in width, and the earth has sunk for several hundred feet over this area. The shale has been burnt to a loose powder, discolored and vitrified. Some of the shale has been coked and at the present time shows all the prismatic colors. Numerous other instances of the occurrence of these fires could be mentioned, all existing in the neighborhood of petroleum or asphalt deposits. Adjoining these hot places the shale which is not burnt contains carbonaceous matter intimately mixed.

Waters strongly impregnated with all the mineral ingredients of strong thermal waters always accompany the ascent of the bitumens in California and in most cases, if not always, in their ascent in other countries.

These minerals were all present in the shales before distillation was commenced, and were derived from the shales through the agency and solvent qualities of hot waters and vapors.

These waters could only have held in solution the quantity of mineral ingredients which they contain through the action of heat. Cold water could not have dissolved so much mineral matter. When these waters cool, the ingredients which are held in solution by heat alone are usually deposited.

In drilling wells for petroleum these waters are penetrated. They all have different temperatures, ranging from that of the surrounding earth to the boiling point. Encountering these mineral waters is an indication of the presence of petroleum or asphalt.

In California these waters contain:

- Chloride of sodium, potassium.
- Carbonate of sodium, potassium, magnesium, calcium, manganese.
- Sulphate of sodium, calcium, aluminum, magnesium, potassium, iron.
- Bicarbonate of sodium, magnesium.
- Ferrum peroxide.
- Borates, lithiates, iodides, bromides, sulphides, arsenic, silica, alumina, sulphuric acid.
- Carbonic acid gas, sulphureted hydrogen, nitrogen, carbureted hydrogen.

There are mineral springs having these minerals without there being any bitumen present. These probably originate in rocks destitute of carbonaceous matter; but there are no bituminous springs unless they are accompanied by these mineral waters.

When the flow of these mineral waters ceases, the flow of bitumen ceases. In places where the flow has ceased the earth surrounding the indurated bitumen is highly charged with some of these minerals, which have during the flow infiltrated into the surrounding earth.

These minerals are intimately incorporated with all asphaltum, pissasphalt and petroleum. This must have been effected during distillation, otherwise they could not be so thoroughly mixed. Some are so thoroughly combined that they seem to be a chemical combination.

From some of these bituminous and mineral springs waters to the extent of 30,000 gallons flow daily.

Some of these bituminous and mineral springs must come from a long distance or through very tortuous passages and very slowly; for when they reach the surface they are cool, although the most of them have a temperature exceeding that of the surrounding earth, and rising to the boiling point.

Near the Buenavista deposit, in Kern County, there is a spring from which gas, oil, sulphur, and other minerals issue with the water.

This heat in the shale is partly of mechanical origin. The shale in which this heat occurs is tilted, contorted, and broken. When it is under heavy pressure, at a considerable depth, a slight movement is capable of producing sufficient heat to start the distillation of the carbonaceous matter in the shale. When this commences, the movement of the shale will continue; the movement increasing, the heat will increase. When carbonaceous material is distilled from the shale, a contraction occurs, permitting the movement and subsidence of considerable areas of ground. This subsidence has happened on Las Pozitas rancho, near Santa Barbara; on the Santa Rosa rancho, near Los Alamos; also at Buenavista, near Bakersfield, and many other places. When the shale is hot, superheated steam may increase this movement. Earthquake shocks would have a tendency to stir up the material in nature's still, producing an increased flow of the distillate. A well dug in Santa Clara County, in which no signs of oil had been shown prior to the shock, yielded oil afterward.

The flow of petroleum and pisasphalt from these springs is limited, but a few tons are being produced annually, the largest producing about 50 tons.

At H is a deposit of infusorial earth, which contains diatoms similar to those found in the hot springs of the Yellowstone. Its position would also show that it is a deposition of a spring.

Subterranean heat distills bitumen from the carbonaceous shales. This distillation has produced hydrocarbons ranging from attenuated gas to that which is viscous and tar-like. These grades are owing to the multiform conditions of distillation, wide difference of temperature, modes of condensation from extreme rapidity to immeasurable slowness, violent agitation to quiescence, distilled and condensed a number of times, the great variety of carbonaceous matter contained in the shale, in the presence of foreign matter, gaseous, liquid and solid, under tremendous pressure or slight or no pressure. The most of these conditions being changeable and interchangeable, become infinite in number.

After distillation the petroleum or pissasphalt, by operation of its own gravity as compared with that of some other fluid, or by reason of hydrostatic pressure, or the presence of gas or of capillary energy, or all of these combined, flows to the surface of the earth or locates in porous rock or in the cavities, rifts and fissures of rocks. Probably large quantities of petroleum, owing to the lack of these forces of nature, never reach the surface and still remain in the neighborhood of the places in which they were distilled. As soon as it has been in contact for some time with the air, as soon as it has remained for some time in the upper strata of the rocks accessible to air, it undergoes an essential change by oxidation and evaporation.

Generally the oxidation and evaporation of the petroleum to pissasphalt and asphaltum has been completed in sand and loose sandstone, in which opportunity for circulation and multiplied reciprocal movement is offered to the oil as well as the oxygen of the air by means of the interspaces between the grains of sand. Also the oxidation and evaporation of petroleum occurs during the slow ascent of the petroleum in the fissures, rifts, cracks, seams and fractures and other passages in shale and other rocks.

A porous stratum, acting as a reservoir for the bitumen, is shown in the sectional view.

A to B, laminated and bitumenized sand; C, Eolian sands, the surface of which contains some loam.

D D, shale containing carbonaceous material with seams filled with pissasphalt and petroleum. This shale has a dip of 70° toward the south. The strike of the shale is N. 70° W.

The impregnated sand, A to B, has a nearly horizontal lamination, but is contorted in places by the ascent of the pissasphalt. The lamination is plainly discernible by the different degrees of coarseness and by the color of the sand. This sand was deposited by the sea. The shale was evidently tilted and then the sand was deposited, and the shale and sand again tilted.

The inclination of the sand containing the bitumen is toward the northwest. How much this inclination is cannot be at present determined, as the deposit has not been sufficiently explored, but as far as can be determined it amounts to 5°. On top of the bitumenized sand is a cover of unstratified sand blown up by the winds from the present ocean beach. This sandy cover has been bleached by the ascent of gas to a light yellow near the bitumenized sand, and turning to a brownish yellow as the distance from the bitumen increases. This bleached sand is from eight to ten feet thick.

The top of the bituminized sand has a hard impervious crust, caused by the volatilization and oxidation of the pissasphalt. The bitumen in the bitumenized sand becomes more liquid the further it is removed from atmospheric influences. The bitumen is not indigenous to this stratum. The pissasphalt ascended and is now ascending through the shale and impregnating the sand. The ascent of the bitumen is accompanied by water having the mineral ingredients of strong thermal waters.

Several natural wells of bitumen from four to five feet in diameter have been found in the bitumenized sand. Small pissasphalt springs ooze through the bitumenized sand in numerous places.

At the mouth of the Carpinteria Creek, where this deposit is at present mined, the sand which contains the pissasphalt is of quartz, spherical, fine, hard and translucent, and remarkably free from silt, and carries from 15 to 18 per cent. of bitumen.

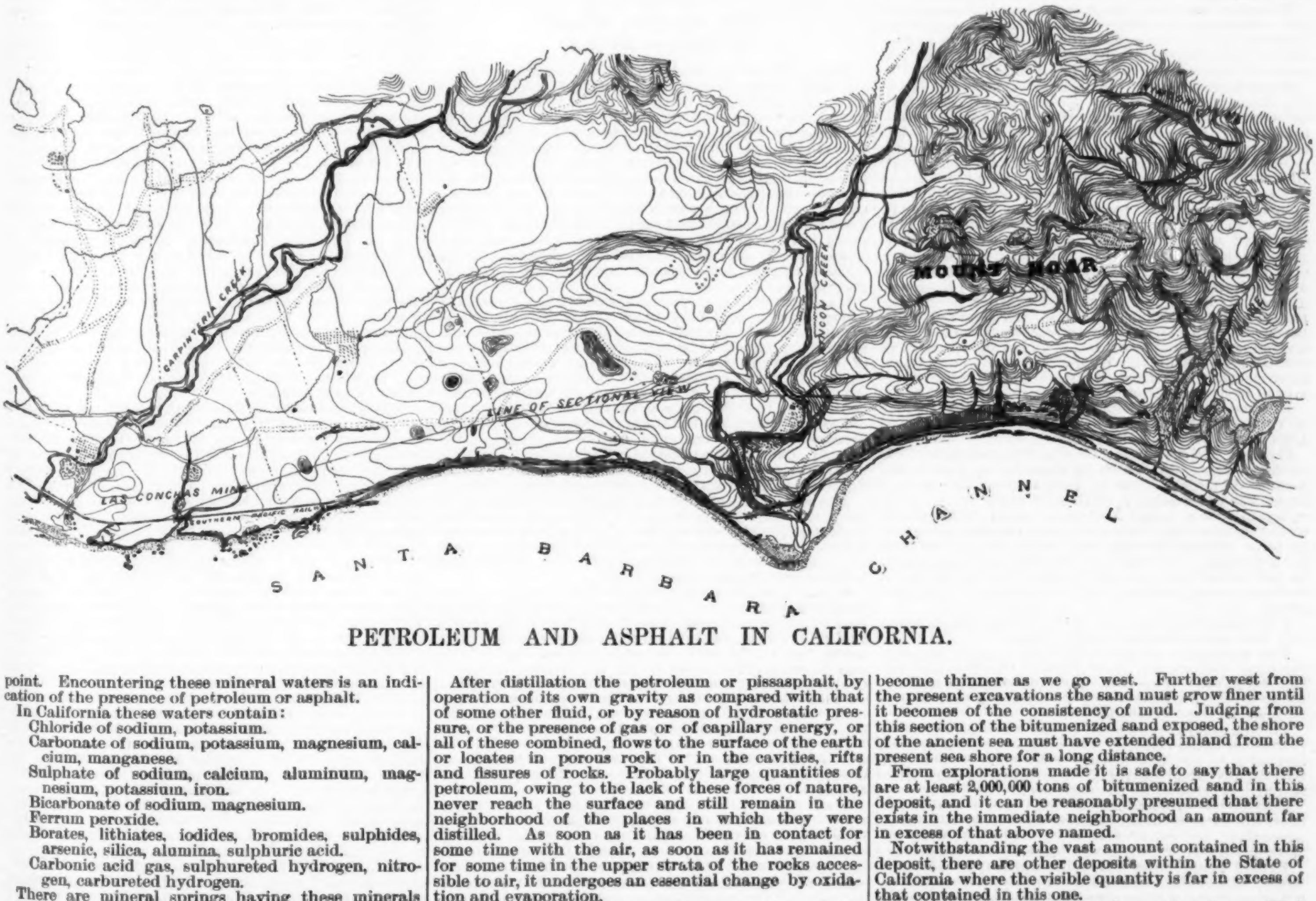
This sand deposit has once been the sea beach, before it was saturated with the bitumen. The eastern end, which is exposed on the bluff of the present ocean, is composed of lenticular masses of gravel, beds of shingle and coarse sand, with fragments of marine shells, evidently deposited near the surf of an ancient sea. The further we go west the finer the sand becomes and the freer it is from silt and fragments of shells. When it reaches the excavations being made at present, about three-fourths of a mile from the east end of the deposit, the sand is very fine and clean, and must have been deposited in fairly still water. The laminæ of the sand become thinner as we go west. Further west from the present excavations the sand must grow finer until it becomes of the consistency of mud. Judging from this section of the bitumenized sand exposed, the shore of the ancient sea must have extended inland from the present sea shore for a long distance.

From explorations made it is safe to say that there are at least 2,000,000 tons of bitumenized sand in this deposit, and it can be reasonably presumed that there exists in the immediate neighborhood an amount far in excess of that above named.

Notwithstanding the vast amount contained in this deposit, there are other deposits within the State of California where the visible quantity is far in excess of that contained in this one.

At J on sectional view and map is a fissure filled with hard asphalt containing about 30 per cent. of bitumen, the remainder being fine shale and some sand. Innumerable numbers of small seams filled with heavy tar-like bitumen supplied this fissure with the bitumen. The comminuted shale and sand, now existing in the asphalt, was gathered by the bitumen by friction from the sides of the seams and fissure during its ascent and was ground to a fine state and intimately mixed by the motion of the asphalt. This asphalt when it ascended was in a plastic state similar to that of putty. When distillation and the ascent of bitumen and the mineral waters ceased, the heat was changed from a moist heat to a dry one. Holes exist through the asphalt, through which hot fumes escaped, burning the asphalt and clay. This dry heat volatilized all the liquid hydrocarbons, leaving it hard and dry.

The La Patera asphalt mine, near Santa Barbara, consists of a similar fissure filled with plastic asphalt, containing 66 per cent. of bitumen and 34 per cent. of fine shale and a small amount of sand. The volatile hydrocarbons have not yet all been driven off by dry heat. This plastic asphalt is constantly ascending. Some twenty years ago part of the bitumen in this fissure was excavated to a depth of fifteen feet. It was filled up again with asphalt and, when recently excavated, vertical banks showing the marks of the pick



PETROLEUM AND ASPHALT IN CALIFORNIA.

were found, and at the bottom of the excavation a sledge hammer. This asphalt is constantly rising in the bottom of the tunnels and drifts in the present system of excavation. This fissure contains a large amount of asphalt of a uniform grade. The ascent of the bitumen is accompanied by mineral waters. In portions of the mine the temperature of 105° Fah. is reached, owing partly to the friction caused by the movement of the asphalt.

There are but few anticlines in the oil regions of California, and in these the curvature is so acute that a large majority are fractured to such an extent as to be incapable of acting as a reservoir for oil without the induration of the bitumen described hereafter.

The main reservoirs of oil and pissasphalt in California are porous strata of sand, generally existing in menoclines. These strata of bitumenized sand exist at many different depths below the surface, standing at many different angles and having confused strikes.

Vacancies in the shale, such as fissures, seams, rifts, fractures, etc., often act as a reservoir, but they are small in comparison to those formed by the porous sand rock.

The quantity of bitumen contained in bitumenized sand depends largely upon the quality of the sand. The voids are generally filled with bitumen and no more. If the sand is coarse and free from silt, a large amount of vacancies or voids exists. The coarser the sand, the more the voids or vacancies.

The proposition that the voids only are filled is true in some cases, but not in all. For instance, when a cover is formed on the surface of a stratum of bitumenized sand by the evaporation and oxidation of petroleum into asphaltum, the force exerted behind this impervious cover by the ascent of the pissasphalt pushes this cover forward or upward, and the pissasphalt, mixed with silt and sand, accumulates behind this cover, which becomes indurated into another cover, and this in turn is pushed forward. This mode of action, continued for a long period, has created large deposits which contain bitumen far in excess of that which is required to fill the interspaces in the sand.

The retention of petroleum and pissasphalt in the porous rocks cannot be effected without the accumulations or reservoirs having a cover or an impervious incasement. This impervious incasement usually consists of shale or close textured or grained rock.

When the outcrop of bitumenized sand is exposed to the atmosphere for a long period, the bitumen contained in it loses its volatile parts and turns brown, and is easily pulverized between the fingers. The sand separates from the bitumen and the bitumen is easily ground into an impalpable powder. This brown asphaltum extends to but a short distance below the surface of the stratum. Beneath this brown coating the bitumenized sand deposits receive a coating of hard asphaltum made hard by evaporation and oxidation. This concreted surface is nearly impervious to the flow of pissasphalt and petroleum. Especially is this true in cold weather, the coldness congealing the pissasphalt and asphaltum, so that little or no flow of oil occurs. This crust sometimes softens in hot weather, permitting the tar to flow. In fact, all porous bitumenized rocks become water and petroleum by reason of the petroleum becoming concreted by oxidation and evaporation. The surface of the bitumenized sand is concreted and hard, increasing in liquidity as it enters the deposit or is removed from atmospheric influences.

In some deposits a short distance from the surface will show a petroleum oil of 10° Baume, decreasing at 1,000 feet to 32° Baume.

If rather stiff maltha is melted and poured into a hole in sheet iron $\frac{1}{16}$ of an inch in diameter, so that it will form a thickess of $\frac{1}{16}$ of an inch on each side of the sheet, the sheet being $\frac{1}{16}$ of an inch thick, it cannot be removed with a pressure of water equal to 50 pounds to the square inch. The prodigious pressure necessary to force maltha through the interspaces of the sand for a distance of several hundred feet can be imagined. In fact the salvation of oil accumulations in California is owing to this induration of the petroleum or pissasphalt.

This impervious coating also protects the oil reservoir from the entrance of surface water.

The petroleum or pissasphalt, in passing through the sand, collects the silt which is in the sand and carries it forward. This also assists in forming a cover, filling up the places through which the liquid hydrocarbons attempt to escape.

The indurated incasement of reservoirs produced by petroleum being changed into asphaltum in nearly all instances is not sufficiently impervious to keep the natural gas from escaping. Consequently very little stored gas is found in the deposits of California.

Besides the subterranean accumulations of asphalt, there are surface accumulations caused by springs of pissasphalt and heavy petroleum. The following are the general characteristics of these bituminous springs:

In cold weather the flow is diminished or ceases entirely. All of the recent deposits have been formed by a flow of pissasphalt or petroleum from springs, most of which are in active operation at the present time.

When pissasphalt or petroleum has run over steep grades, no beds of asphaltum have formed. When it has run upon places so flat that the viscous flow has been arrested, the tar has hardened into asphaltum. Where the soil was porous and dry, the tar has sunk into the underlying soil while liquid, and then hardened. In places where the soil or rock could not be penetrated by the tar, or where the soil was moist and sufficiently flat, the pissasphalt has evaporated, forming ponds of asphaltum. Where the tar has flowed over steep grades, a thin coating of tar has glazed the surface of the earth; and where the volatile oils have evaporated from this glazing, it has become very brittle, and generally breaks into pieces, and is washed away by rains.

Almost all of these springs of bitumen show evidences of having been frequently burned, as the materials immediately surrounding the springs have become coked and hardened by repeated fires. In former times the Indians used to set them on fire for the warmth afforded and for cooking purposes. Rude utensils for cooking, such as were used by the Indians, are found near these springs. After the Indians disappeared, these springs were set on fire by shepherds, in order to destroy the tar, as lambs and sheep were often smothered in it. At the present time they are covered with brush to keep the sheep out of them.

The Sunset deposit is caused by tar springs situated on the top of a ridge. The pissasphalt runs toward the southeast. The ground for a hundred feet adjoining the spring is so steep that no pissasphalt has deposited at this point. On more level ground the pissasphalt has concreted into a deposit of asphalt varying in thickness from one to four feet. The prospecting done indicates that this deposit contains 1,500 or 2,000 tons of asphalt, averaging 50 to 70 per cent. of bitumen. The ascent of the bitumen in the spring is accompanied by a slight amount of salted water.

The marsh deposit near Sunset has been formed from the flow of several tar springs. These springs also yield salty water, which forms a small marsh. The first 100 feet of the surface of the ground next to the springs is so steep that no asphalt has been deposited. It then flows over fine powder of burnt shale. When heated by the sun it percolates into this finely powdered shale. The winter rains and the winds bring down a fresh supply of powdered shale, which in its turn is permeated with the liquid tar. This deposit has not been prospected. From surface indications it is fair to assume that there are 10,000 tons of fine shale impregnated with from 15 to 20 per cent. of bitumen.

The Buenavista deposit is formed by the flow from a large tar spring. The ascent of the bitumen is accompanied by a slight amount of mineral water. For the first 200 feet from the spring, the ground descends so rapidly that no tar has solidified upon it. From this point and for a distance of 1,000 feet asphalt has been formed from the washings of finely powdered shale from the surrounding hills and the flow of the mineral tar. The tar has permeated the powdered shale and formed an asphaltic rock containing from 15 to 20 per cent. of bitumen. From surface indications and indications in the ravines on each side of the deposit, it is safe to say that 40,000 tons of asphalt of the purity mentioned exist at this place.

From all the present indications, these surface deposits have accumulated with inconceivable slowness.

Santa Barbara, Cal., August, 1893.

THE PACIFIC OCEAN.

By RICHARD BEYNON.

VASCO NUNEZ DE BALBAO, when he led his exploring party across the wilds of Panama, and gratified their astonished eyes with the sight of a mighty sea stretching to the westward horizon, little thought of the magnitude of the immense ocean he had discovered. Though he was the first European to gaze upon the illimitable waters of the "Great South Sea," it was reserved for the unfortunate Magellan to demonstrate its vastness in a practical manner. This he did by traversing the strait which now bears his name, and successfully emerging therefrom on the 27th November, 1520, seven years after Balbao's discovery, into a vast and unknown but calm and peaceful sea. He named it the "Mar Pacifico," a title which, however undeserved, it still retains.

Magellan, with his little fleet, reached the Philippine group after a voyage of much hardship, only to lose his life in a rash skirmish with the natives. The remnant of the expedition returned to Europe by the Cape of Good Hope, having successfully navigated the world. The Spanish conquests in Central and Southern America, and the prosecution of mercantile adventure by the Portuguese in the East Indies, soon did much to open up the trade routes of the Pacific, a process which was hastened by the readiness of the British adventurer to follow in the wake of the don, invariably reaping the profit, the seeds of which the Spaniard had sown with so much hardship and labor.

The ocean thus exploited during the middle years of the sixteenth century is by far the largest of all the divisions of water, embracing as it does some seventy-five millions of square miles of surface, contained within an area whose maximum length and breadth are 9,000 and 12,000 miles respectively.

A glance at the map serves to bring out the more salient features of the boundaries of this great oceanic basin that covers more than a quarter of our earth's surface. To the south the Pacific merges into the Antarctic, but to the north the converging shores of Asia and North America meet under the shallow waters of the Behring Sea, and Siberia would be visibly connected with Alaska were it not for the forty miles of Behring Straits that comes between. The separation, however, is more apparent than real, the bottom being found at but little depth from the surface, so that a slight upheaval of the sea-bed would suffice to effectually landlock the Pacific at its northern extremity.

The disparity between the eastern and western shores is most strongly marked. The American coast is bold and precipitous, the inclosing banks being in reality the coast ranges of North America and the Andes of South. From Vancouver to America's most southern promontory the coast line may be regarded as volcanic, the convulsions of nature having as it were splintered the rugged shores and formed the fringe of rocky islets which are the only pretensions to insular extensions which this coast line possesses. But few rivers pour their tributary floods into this section of the Pacific, and the majority of these are mere cascades which tumble from the mountain summit which gives them birth to the sea at its foot. The total area of American lands draining into the Pacific is but half a million square miles, an aggregate which contributions from Asia and Australia swell to eight and a half millions. But even this total is far behind the drainage received by the Atlantic, for the rivers flowing into it drain areas variously estimated at from eighteen to twenty millions of square miles. The Asiatic littoral of the Pacific differs vastly from that of America. Instead of being a high, barren and unindented coast, it is, for the most part, low and fertile, with many openings, river mouths and festoons of islands. The Pacific coast of Australia somewhat resembles that of South America in that the mountain chains lie near the shore, and thus preclude the possibility of a big drainage area. The sea-bed of the Pacific does not present the same uniform features as does the Atlantic. There are not the same areas of dead level as are encountered on the floor of the ocean that separates Europe from America. A submarine ridge, however, on which the depth is tolerably uniform, stretches from the northern coast of Chile to the Japan Islands, while from this bank the bed rapidly declines into abysses, which lie from 2,000 to 3,000 fathoms from the surface. The average depth of water over this submarine plateau is about 1,500 fathoms. A crescent-shaped patch of deep water extends from the Japan Islands to the Kuriles, from 50° N. to 20° N., and nowhere here does the ocean surface lie nearer than 4,000 fathoms from the sea-bed. The Challenger sounded 4,575 fathoms at Papua, near the Admiralty Isles, and the Tuscarora, while sounding over the deep ditch-like recess across the entrance to the Sea of Okotsk, found several depths of over 4,500 fathoms, and a maximum one of 4,643 fathoms in the neighborhood of the ridge upon which the Japan group stands. The Asiatic Islands may be regarded as having formed at one time a portion of the Asiatic continent, and in many cases a slight elevation of the sea-bed would not only suffice to join islands to mainland, but also to raise some of the shallower seas above the existent sea level. Thus the Sea of Okotsk is nowhere deeper than 1,000 fathoms, while much of it lies well within the 100 fathoms line. The Yellow Sea has no part of its bed removed to a greater distance from the surface than 100 fathoms. The Sea of Japan on the other hand is deep, much being between 2,000 and 3,000 fathoms.

Some interesting facts relative to the Pacific depths have recently been obtained by the United States ships Albatross and Thetis in surveying possible routes for a cable between San Francisco and the Hawaiian group. Starting from Monterey Bay, close to 'Frisco, a deep trough was found carrying deep water close to the shore. A great circle course was then followed to the Island of Oahu, soundings being taken on an average every 10 miles. The depth gradually increased to 490 miles from shore, where it was 2,900 fathoms. The sea-bed then rose a little, until at a point 690 miles from the Californian coast it was 2,015 fathoms. In the next 146 miles the depth increased again to 2,700 fathoms. In 31° 54′ N. 136° 44′ W. the deepest water of the cruise was found, the sounding line showing 3,186 fathoms. After this depth there came a slight rise to 2,085 fathoms. A stretch of 700 miles followed with a depth of 2,900 fathoms. Some 210 miles from the east end of Oahu an elevation was found 1,256 fathoms from the surface. It was only reasonable to suppose that from this point the floor would gradually rise until the land was reached, but strange to say this submarine bank was separated from it by deep water where the sounding line recorded 2,800 fathoms. Still, however, the rise to the shore was gradual, and no insuperable difficulty was found in the route sounded over for the proposed cable. On the return journey by a course which did not diverge much from the route sailed over on the voyage out, the results obtained were somewhat similar. Twenty miles from land the depth was 600 fathoms, which increased to 1,800 fathoms in the next four miles, and notwithstanding the steepness of the descent no rocks were indicated. The Thetis surveyed another line of route in April of last year from Point Conception to Hilo in Hawaii, and found that on the whole the sea-bed was more rugged than on the other courses. A remarkable shoal patch, with 976 fathoms of water over it, was found 405 miles from Point Conception, the surrounding ocean having an average depth of 2,500 fathoms. At a point 230 miles from Hawaii was found the deepest water of the cruise, and here the sounding line touched the bottom at a depth of 3,230 fathoms.

The temperature in these great depths is of course very little removed from the freezing point. A steady creep of icy water from the Antarctic Ocean flows slowly along the floor of the Pacific, and meeting no corresponding current from the Arctic Ocean, finds its way to a considerable distance of the line. Taken as a whole, the mean temperature of the Pacific bottom water is quite one degree Fah. lower than the same average for the Atlantic. In the North Pacific this mean is 35°; in that section lying within the tropics it is about the same. Along the 40th parallel south it is 34·6°, and in the comparatively shallow area adjacent to the Patagonian plateau 35·4°. The surface temperature is to a great extent subject to seasonal variation. There is an exception to this, however, in the Southern Pacific. Here the isotherm of 40° is practically constant all the year round, its oscillation being confined to the limits between the 55th and the 58th parallels. This is no doubt owing to lowering of the summer temperature by the mixing with the ocean of the colder waters resulting from the melting of the Antarctic icebergs. Between 45° N. and 45° S. the temperature does not drop below 50°. There are two localities of maximum temperature. One is in the Malay Archipelago between the Pacific Ocean and the Indian, while the other is a narrow area adjacent to the Mexican coast. In these sections the mean for the hottest month of the year is 85°. Between New Guinea and Japan the August temperature shows an average only one degree below this. When the Challenger made her observations in the South Pacific it was found that the water showed a uniformly higher thermometric reading than the air by an amount which varied between 1½ and 2 degrees. This finding was reversed in the North Pacific, where, between the latitudes of 30 and 40, the atmosphere showed an average higher temperature of half a degree.

We have already mentioned an influx of Antarctic water into the Pacific. The surface drift flows as the Humboldt Chilean or Peruvian current along the South American coast until it comes well within the influence of the trade winds. It is now deflected toward the Asiatic coast, forming the great equatorial current of the Pacific. This surface stream is divided into two sections by a counter current or drift flowing in the opposite direction. The Antarctic drift makes its presence felt at the Galapagos Islands right on the equator, and some 500 or 600 miles from the South American continent. The cooler water and the food supply which the Antarctic water supplies serve to support a species of penguin, a bird which is native to the frigid zones of the world.

Perhaps the most striking feature of the North Pacific current system is the famous Kuro-Siwa or Japan current, the Gulf Stream of the Pacific. This surface stream flows from the Philippines past the Japan group as a well defined current, carrying a vast store of heat from the tropics to parts further north. Off the Kuriles it bifurcates, one branch entering Behring Sea, while the main sweeps across to the Alaskan and Columbian shores, afterward following a southerly

route along the American coast. Part of it continues on this course past Mexico and takes the name of the Mexican current, the remaining section, under the influence of the northeast trades, being deflected to form the equatorial current of the North Pacific, thus performing a complete circumvolution. It is worthy of note that in the North Pacific the current helix follows the direction of the hands of a watch, a motion which is reversed in the section lying south of the line.

Dr. Gerhard Schott, the well-known German *savant*, has of late added much to previous information on the subject of this current in particular and ocean currents in general. Much of his knowledge has been obtained from a study of the logs of German merchant and other vessels, and some from his own observations made during an eastward voyage on a big four-poster. Dr. Schott is of opinion that the current is not so extensive as generally supposed. "The supposed constant current of considerable velocity just east of the Lu-Chu Islands, does not," he says, "exist." About the 38th or 39th parallel the Kuro-Siwa strikes the Oga-Siwa, which is the Labrador current of the Pacific. This stream has skirted the Kurile Islands, and meeting the warmer waters of the Kuro-Siwa, produces phenomena akin to those occurrent off the banks. The observations of ships in this region show that often in a few hours the temperature of the water falls 20° or 30°, and produces a corresponding reduction in aerial heat. Fogs and rain occur, and the color of the water changes from the characteristic blue-black to bottle green. The boundary line between the Kuro-Siwa and the Oga-Siwa from February to April is 38° N. and 143° to 145° E. long. In May it is 42° N. and 147° E. In July, 45° N. and 150° E., while in August the warm current pushes back the colder one to 50° N. At no period of the year does this Polar current reach further than 38° from the line. Just as the western edge of the Gulf Stream is sharply defined against the cold water creeping down the American shores, so that margin of the Kuro-Siwa in contact with the cold water running down the China coast is crisply marked by a definite line of demarkation, while its eastern border is indistinct and in some places unobservable.

The mixing of the waters by the surface circulation gives rise to other variations in the temperature of the upper layers of water than those produced by difference of latitude. Thus from a point about 200 or 300 miles westward of the Galapagos Islands the mean temperature of the surface water along the equator is 80° Fah. Between this point and the South American coast, however, the average of observations gives 70° Fah. as the mean temperature. At the meeting of the waters near the north of the Japan group patches of warm water are often found surrounded by colder areas, the warmer water generally being revealed by the superincumbent fog which results from the partial condensation of the aqueous vapor contained in the air resting upon the warm patch.

Great differences have been observed in the specific gravity of the surface water of the Pacific. When the many factors are considered which influence the salinity of the ocean's surface, this is not to be wondered at. Thus, in the China Sea, during the month of November, the specific gravity of the surface water is 1·02518, distilled water being represented by unity. This increase in density over pure water is equivalent to 3·3765 per cent. of dissolved salts, which is but a small percentage, for the average for the whole ocean is three and a half per cent., which gives a density of 1·026. November, of course, marks the close of the southwest monsoon, and this implies that the China Sea has been swept by a moist wind which has precipitated much rain upon it and at the same time retarded evaporation. Such being the case, it is only logical to expect a higher salinity during the northeast monsoon, which having crossed masses of land is drier, and thus in a condition to induce a more copious evaporation. Accordingly we find in January that the specific gravity of the surface water increased to 1·02534. The mean for the year in the China Sea will thus be 1·02526. Low as is the amount of salts there held in solution, it is even less in the rainy region of the equatorial counter-current, where the mean for the year is so low as 1·02485. Perhaps the most striking feature that a study of the specific gravities of Pacific surface water shows is the low density of the water among the islands of the Eastern Archipelago, in the western section of the Pacific. Here, although the full force of the tropical sun insures a high surface temperature, the water is, comparatively speaking, fresh, the density being no higher than 1·02550. The explanation of this fact is no doubt owing to the constant humidity of the atmosphere and the copious rainfall. Many of the islands are mountainous, and, as the amount of precipitation exceeds 200 in. per annum, the fresh water discharged into the sea in this area must, of course, be considerable.

Taken as a whole, the surface waters of the North Pacific have a lower density than those of the South. The maximum for the northern division is 1·02650, while in the corresponding section of the southern portion of this ocean the area of maximum salinity has a mean density of 1·02750, which shows a percentage of dissolved matter considerably in excess of the three and a half per cent. which is the mean for the oceans of the world.—*Nautical Magazine.*

TESTING PLANE SURFACES BY INTERFERENCE PHENOMENA.

AT a recent Friday evening lecture at the Royal Institution, says the *Engineer*, Lord Rayleigh stated that he intended to confine his attention to one branch of interference phenomena—that in which two surfaces close together show interference bands when light is thrown upon them, as in the case of Newton's rings. When the latter are produced by means of a convex surface of glass upon a plane glass plate, the results are deteriorated by means of reflections from the front surface of the plano-convex lens and from the back surface of the plane piece of glass; the latter reflections can be abolished by suitably blacking the glass; the former are not so easy to deal with, but can be thrown on one side by means of a wedge-shaped piece of glass, placed in optical contact with the plane surface of the lens by means of oil of turpentine or other suitable medium. By these methods it is possible to get rid of false lights. Interference bands will then show when the glasses are placed farther apart than before; they are always there, but under ordinary circumstances are much obscured by the false lights. Young guessed the cause of these interference effects; it is a question of phase; that is to say, whether the waves of light which produce the bands co-operate with or interfere with each other.

The illustration of these phenomena by means of sound, he said, has a certain degree of novelty. He here drew attention to his bird whistle—recently described in these pages—which steadily emits sound waves of high pitch. The length of each wave is about 1 cm., with 30,000 complete vibrations per second, and its effects are indicated by means of a sensitive flame, as formerly described. As a reflector he placed, some feet in front of the whistle, a sheet of perforated zinc, which caused the flame to flare and to shorten. A little behind the one sheet of perforated zinc was another parallel with it, and as the latter was moved backward and forward, in certain positions it caused the flame to cease flaring, and in others to flare again. These results, he said, were due to the interference of sound waves; still, there was a difference between the two cases. When the two zinc plates touched each other they co-operated, but in a thin enough soap film producing interference effects with light, the two surfaces do not co-operate with, but oppose each other.

In some apparatus used for experimental research by the speaker, a large lens was employed as at A, Fig. 1;

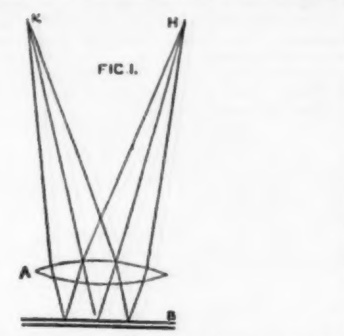


FIG. I.

the two surfaces producing interference are represented at B: monochromatic light, as nearly pure as possible, emanates from H, and the eye of the observer is placed at K. The lens renders the rays parallel. By this arrangement the plates at B are seen covered with bands, which are dark where the waves of light are in such a phase as to be antagonistic.

When photographing the bands, the lens of the camera has to take the place of the eye at K. The photographing is not difficult, but with yellow light extremely long exposures are necessary, and the places have to be specially prepared so as to be more sensitive than usual to yellow rays.

In relation to the subject of testing the truth of plane surfaces, Lord Rayleigh said that the first step was to get a standard of flatness. One method is to get three flat pieces of glass, A, B, and C; if A fits B perfectly, and B fits C, and they all fit each other in every way, they must be flat, but this process is exceedingly difficult to carry out. He had found out that a good way to get a standard of flatness was to use the surface of a liquid at rest, for with the sizes with which he had to deal the curvature of the earth could be left out of account, for that curvature in about four feet amounted to but one-twentieth of a wave length of ordinary light, so might be neglected. Next came the question of capillarity, due to the sides of the containing vessel; but capillarity would not interfere if the experiments were carried on more than 1½ in. from the sides of the vessel, as proved by calculation. Then tremor has to be avoided, wherefore it is almost impossible to work by this method in towns, in which passing vehicles and other disturbing influences set up vibrations. The motes floating in the air set up a great disturbance as they fall into the water, and air currents have a strong effect, hence the plan adopted was to cement the lens on to the top of the vessel containing the water, as at A, Fig. 2. The

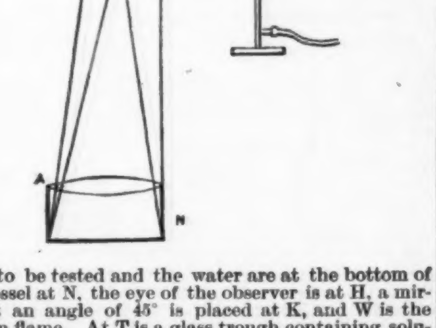


FIG. 2.

plate to be tested and the water are at the bottom of the vessel at N, the eye of the observer is at H, a mirror at an angle of 45° is placed at K, and W is the sodium flame. At T is a glass trough containing solution of bichromate of potash, to cut off any blue light. The basin rests on a heavy iron leveling stand, which in its turn rests upon the solid ground in the basement of his house in the country, and the experiments are carried on at night usually, or when nobody is moving about overhead. The arrangement must be almost air tight, otherwise draughts will set the whole thing flying.

The surface of the water is then compared with the surface under test. Supposing the latter not to be flat, it bends the interference bands, and according to the direction in which it bends them, whether the want of truth is due to convexity or concavity can be told. The surface may be rubbed with rouge to see which way it bends the lines. The best specimens of flat optical glass have usually faults left near the edges. Errors amounting in measurement to one-twentieth of an ordinary wave length of light can thus be detected, and the ordinary wave length of light may be taken at $\frac{1}{50000}$ of an inch.

When truly parallel surfaces are required, mercury and water are used in the apparatus just described, and as the light reflected from the mercury is more brilliant than that reflected from the water, the lights are brought to about the same intensity by dissolving coloring matter in the water. The soda light is then not homogeneous enough, because of the extensive amount of interferences.

In the course of the lecture, Lord Rayleigh projected some extensive series of interference bands upon the screen, some of them exceedingly granular in appearance where they indicated imperfections in the polish of the glass used.

VEGETABLE OILS.

By DE NEGRI and FABRIS.

Oil of Pistachio can be extracted from the seeds by pressure, as also by ether or carbon disulphide; it is of a golden yellow color and possesses a faint odor. When cooled below 0° it remains liquid even at − 8° to −10°, when it suddenly solidifies, but liquefies again at + 5°. It is sparingly soluble in alcohol, but readily in ether, chloroform, and benzene.

The following data are given for the oil extracted by various methods:

Specific gravity at 15°	0·9185
Point of solidification	−8° to − 10°
Fatty acids:	
Melting point	17°—20°
Point of solidification	13°
Iodine number	86·9
Saponification number	191—191·6

The oil gives, with Heydenreich's and Brulle's reagents an orange coloration, and Hauchecorne's reagent a green coloration, changing to yellow when heated. Bechi's, Milliau's, and Baudouin's reagents produce no alteration.

Oil of Walnut can readily be extracted by pressure from not over-ripe nuts, as also from the kernels by ether or carbon disulphide; it is of a yellowish color, and is used in some countries, especially Piedmont, as a good substitute for olive oil.

The following data are given:

Specific gravity at 15°	0 9265
Melting point of fatty acids	16°—18°
Temperature rise	96°
Iodine number	144·5 − 145·1
" of fatty acids	150·05
Saponification number	193·8—197·3

Its specific gravity, rise of temperature, and high iodine number distinguish it from other oils obtained from nuts.

It gives a brown coloration with Heydenreich's, reddish brown with Hauchecorne's, and an intense orange coloration with Brulle's reagent.

Oil of Hemp.—Hemp seeds contain 30—35 per cent. of oil, which can be extracted either by pressure or solvents; when freshly prepared the oil is of a greenish yellow color, but blackens after some time. It is siccative and does not solidify even at − 27°. It is used to admix with colza oil and in the preparation of varnishes. It is composed of the glycerides of linoleic, oleic, palmitic, and stearic acids.

The following data are given, which are for the most part in accord with those of previous observers:

Specific gravity at 15°	0 928
Fatty acids:	
Melting point	17°—19°
Point of solidification	14°—15°
Iodine number	140·5
" of fatty acids	141
Saponification number	192·78

The oil gives greenish brown colorations with Heydenreich's and Hauchecorne's reagents, and reddish brown with those of Brulle and Bechi.

Oil of Jatropha Curcas (*East India Nut*).—The *Jatropha Curcas* is a species of the *Euphorbiaceæ* family, indigenous to the Cape Verde Islands, as also to Cuba, New Granada; it grows to a height of about 4 meters.

The seeds contain 30—40 per cent. of an oil extracted by pressure, of yellowish color, and without distinct odor. It contains ricinoleic, stearic, palmitic, and myristic acids; it is used in soap manufacture, for the adulteration of olive oil. It possesses cathartic properties; it is completely saponified only after prolonged boiling with potash, and not readily, as stated by Horn (Zeits. Anal. Chem., 1888, 164; this journal, 1888, 142). The oil dissolves in 100 parts of alcohol, and is soluble in all proportions in chloroform, ether, and benzene. A white crystalline solid is deposited from the oil, when kept at 10°, which Maillot identified as palmitin.

The following data are given:

Specific gravity at 15°	0·92
Point of fusion of fatty acids	24°—26°
Saponification number	210·15
Iodine number	100·91
" of fatty acids	105·05

The oil gives a brown coloration with Heydenreich's reagent, and a reddish coloration with Hauchecorne's and Brulle's reagent. It can be distinguished from castor and croton oils by its different solubility in absolute alcohol, petroleum, and glacial acetic acid.

Oil of Soja Hispida (*Soja Bean*).—The *Soja Hispida* is a herbaceous plant of the *Leguminoseæ*, indigenous to China and Japan, where the seeds are highly valued as a comestible.

The seeds contain a large quantity of a fermentable sugar, as also a ferment similar in its properties to diastase; the oil, present in the proportion of 14 to 18 per cent., can be extracted by pressure or by means of ether; it possesses laxative properties, a yellowish brown color, and a slight aromatic odor. It readily

solidifies, and is intermediate between the siccative and non-siccative oils.

The following properties are given, which are confirmatory of those obtained by Stingl and Morawski (Chem. Zeit., 1886, 140):

Specific gravity at 15°	0·924
Point of solidification	8°—15°
Fatty acids:	
Point of fusion	27°—29°
" solidification	23°—25°
Temperature rise	59°
Iodine number	121·3
" of fatty acids	122
Saponification number	192·5

The oil gives, with Hauchecorne's reagent, a dirty white coloration in the cold, but deep orange when heated; with Brulle's reagent a deep orange but no coloration with Bechi's reagent.

Oil of Coffee Berries.—The fatty oil of coffee can be extracted from the powdered berries by means of ether; traces of caffeine are removed from the solution by agitation with water slightly acidulated with sulphuric acid, and then the ether is completely eliminated by prolonged warming on a water bath under reduced pressure. The oil thus obtained is of greenish brown color, and possesses a slight odor of coffee; it is sparingly soluble in cold alcohol, but completely soluble in twice its volume of boiling alcohol, insoluble in cold, more readily in hot acetic acid.

It is partially carbonized by Maumene's test, with considerable evolution of sulphur dioxide; it is readily saponified by alcoholic potash, and the soap formed can be completely salted out from an aqueous solution, from which cholesterin can also be obtained by agitation with ether. The fatty acids from the oil are of a bright yellow color and without odor.

The following constants are given of the oil obtained from various specimens:

Specific gravity	0·951
Point of solidification	2°—6°
Fatty acids:	
Point of fusion	37°—41°
" solidification	33°—37°
Temperature rise	53·5°—55°
Iodine number	78·6—86·48
" of fatty acids	81·8—90·35
Saponification number	165·1—173·37
" of fatty acids	172—178

The oil gives with Heydenreich's reagent a reddish brown coloration and an olive green, changing to brown, with Hauchecorne's reagent, as also with hydrochloric acid.

Oil of Laurus Nobilis (Bay Tree).—This fatty oil is extracted from the ripe berries of the *Laurus Nobilis*, in which it is present in the proportion of about 20 per cent.; it is imported into Venice and Trieste, principally from Spain, Greece, and Crete.

The oil is of a buttery consistency at ordinary temperatures, of a greenish yellow color, has a slightly bitter taste and peculiar aromatic odor; it is composed principally of laurostearin, the glyceride of lauric acid, myristin, resin, camphor, chlorophyl, and an ethereal oil, which imparts to it the peculiar odor it possesses. The oil is used in pharmacy, in veterinary practice, and as an article of food by the Lapps.

The following constants are given:

Point of fusion	32°—34°
" solidification	25°
Iodine number	67·8
Saponification number	197·48

The oil gives a brown coloration with Heydenreich's reagent, a dirty green changing to an orange yellow coloration when heated with Hauchecorne's reagent, and a violet reaction with Brulle's reagent. The oil is frequently adulterated with soap, lard, and with coloring matters, such as indigo, turmeric, and copper salts.

YEAST WITHOUT ALCOHOL.

By M. Krouchkoll, Paris, France.

Green malt is crushed in a mill, an equal weight of flour or suitable starchy material mixed with it at 54° to 56° C., and subsequently about three-quarters the weight of water stirred in. The mash is left for 1¼ to 3½ hours to settle, after which a sufficient quantity of water at a temperature of 95° C. is added that the temperature of the entire mixture, which is kept stirred for 2 to 3 minutes, is 62° to 64° C. A cover is then placed upon the vessel containing the mash, which latter is allowed to remain for about 1¼ hours, after which the cover is removed and the contents of the vessel allowed to slowly cool to 32° C. A quantity of yeast, equivalent to about 10 per cent. of the solid matter, is mixed into a paste with water and added to the mash, together with about 2 parts per 1,000 (on the yeast) of tartaric acid in aqueous solution. At the expiration of two hours, bicarbonate of soda ($NaHCO_3$) or carbonate of potash (K_2CO_3), in the proportion of 2 parts per 1,000, is stirred into the mixture.

About five hours after the preparation of this mash another is made with half the weight of materials employed in the first; in the place of tartaric acid, however, there is added to the second mash in admixture with yeast a like proportion of "hydrochlorate" or carbonate of ammonia. The two mashes are united at a temperature of 32° and the mixture left for 12 hours, when the yeast will be found as a layer at the bottom of the containing vessel, together with pellicles of barley. The product is strained through a sieve, when the yeast passes through and the pellicles are retained. The yeast is now allowed to settle, and is finally washed by decantation with water, intervals of 5 to 6 hours being allowed for it to settle.

MAIZELINE.

By W. P. Thompson, Manchester.

The corn product named *maizeline* is recommended as a substitute for malt in brewing.

Raw corn is ground in a hominy mill, and subsequently passes to a reel or grader in order to separate the hominy from the offal; from thence it passes to a drier, after which it is treated, in a specially constructed cleaning or scouring machine (out of which it is discharged at the bottom), with steam at a temperature sufficiently high to burst the starch granules. The material passes next between rollers, and is thereby flattened into flakes, after which it enters a drier and from thence passes again through rollers, whereby the flakes are broken up into light particles which are subsequently graded. The finished maizeline has the appearance of granulated sugar.

It is urged that inasmuch as "the starch of the corn has been converted by the above process into soluble starch," *maizeline* is much more readily transformed by diastase than any other malt substitute heretofore proposed. It is said to be almost, if not altogether, free from "dextrine."

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